PALÆONTOGRAPHICAL SOCIETY.

MONOGRAPH:

FOSSIL REPTILIA

OF THE

LONDON CLAY.

BY PROFESSORS OWEN AND BELL.

PART I.—CHELONIA.

1849.

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BY

PROFESSOR OWEN, F.R.S. F.L.S. F.G.S. &c.

AND

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ADVERTISEMENT.

When my friend Professor Bell consented to the announcement, by the Palæontographical Society, of a Monograph by himself on Fossil Reptiles of the London Clay, he was not aware of the progress already made in my work on the Fossil British Reptiles. As soon as he saw the proofs of the plates of those from the London Clay he renounced his intention; but, on the completion of the arrangement with the Council of the Society for the publication of my work, he kindly consented to allow his name to be associated with mine in the present Monograph, to which he has contributed a very valuable and important share. The aid, however, which Professor Bell has rendered has not ended with the descriptions which bear his initials. By his careful revisions of those contributed by myself their accuracy has been assured; and I should not have dismissed the sheets containing the determinations of the parts of the complex skeleton of the Chelonia, and the nomenclature applied to them, with the confidence which I now feel, if they had not received the sanction of an anatomist and naturalist who had distinguished himself in a comparatively early part of his scientific career, by his beautiful Monograph on the existing species of the Chelonian order of Reptiles.

It only remains to add, that we have mutually co-operated in ensuring the accuracy of the illustrations, and have been most ably seconded by the experienced artists Messrs. Dinkel and Erxleben, to whom we beg to offer our best thanks.

Our acknowledgments to the kind friends who have liberally submitted their specimens of Eocene Chelonia to our examination are expressed in the text, in which those specimens are respectively described.

R. O.

Family—*Paludinosa.*

MONOGRAPH

ON THE

FOSSIL REPTILIA OF THE LONDON CLAY.

ORDER.—*CHELONIA.*

Family—MARINA.

Genus—CHELONE.

THE majority of the Fossil Chelonians of the Eocene tertiary deposits, defined or described in my 'Report on British Fossil Reptiles,' belonged to the marine division of the order, and to the genus *Chelone;* and as the species of this genus depart least from the ordinary reptilian type in the modification of the bones of the trunk, composing the characteristic thoracic-abdominal case of the order, I propose to commence with them those descriptions of the Chelonian reptiles which fall to my share of the present Monograph.

In order to facilitate the comprehension of the descriptions and figures of the fossil Chelonians, a brief notice is premised of the composition and homologies of the carapace and plastron, or roof and floor, of that singular portable abode, with which the reptiles of the present order have been endowed in compensation for their inferior powers of locomotion or other modes of escape or defence.

In the marine species of the Chelonian order, of which the *Chelone mydas* may be regarded as the type, the ossification of the carapace and plastron is less complete, and the whole skeleton is lighter than in those species that live and move on dry land: but the head is proportionally larger—a character common to aquatic animals,—and being incapable of retraction within the carapace, ossification extends in the direction of the fascia, covering the temporal muscles, and forms a second bony covering of the cranial cavity: it is interesting to observe, however, that this accessory defence is not formed by the intercalation of any new bones, but is due to exogenous growth from the frontals (11), parietal (7), postfrontals (12), and mastoids (8, see T. I, T. III, T. XV).

The bony carapace is composed externally of a series of median and symmetrical pieces (fig. 1, *ch*, *s*1—*s*11, *py*), and of two series of unsymmetrical pieces (*pl*1—8, *m*1—12) on each side. The median pieces have been regarded as lateral expansions of the summits of the upper vertebral (neural) spines,* the median lateral pieces as similar

* Cuvier, Leçons d'Anatomie Comparée, tom. i (1799), p. 212.

developments of the vertebral ribs (pleurapophyses),* and the marginal pieces as the homologues of the sternal ribs (hæmapophyses).†

I must refer the reader to my Memoir, communicated to the Royal Society, for the facts and arguments which have led me to regard these pieces, as dermal ossifications, homologous with those that support the nuchal and dorsal epidermal scutes in the crocodile. Most of the bony pieces of the carapace are, however, directly continuous, and connate,‡ with the obvious elements of the vertebræ, which have been supposed exclusively to form them by their unusual development; the median pieces have accordingly been called "vertebral plates," and the medio-lateral pieces "costal plates." I retain the latter name, although with the understanding and conviction that they are essentially or homologically distinct parts from the vertebral ribs or pleurapophyses with which they are connate and more or less blended. But, with regard to the term "vertebral" plate, since the ribs (*costæ*) are as essentially elements of the vertebra as the spinous processes themselves, I have been in the habit, in my Lectures, of indicating the median series by the term "neural plates," which term has the further advantage of removing any ambiguity from the descriptions that might arise from their being mistaken for the superincumbent epidermal shields, which are likewise called "vertebral plates" in some English works.§ The term "marginal" is retained for the osseous plates forming the periphery of the carapace; but the median and symmetrical ones, which seem also to begin and end the "neural" series, are specified, the one by the term "nuchal plate," the other by that of "pygal plate." The "neural plates" are numbered as in the classical Monograph of Bojanus.‖

In the subjoined woodcut of the carapace of the loggerhead turtle (*Chelone caouanna*) (fig. 1), *ch* is the *nuchal plate*; *s*1 to *s*11 the *neural plates*; *pl*1 to *pl*8 the *costal plates*; and *m*1 to *m*12 the marginal plates. The carapace is impressed by the superimposed epidermal scutes or shields, which consist of a median series, called "*vertebral scutes*" *v*1 to *v*5;

* Ibid. p. 211. Rathké has recently supported this determination by arguments drawn from the mode of development of the carapace. See 'Annales des Sciences Naturelles,' Mars, 1846; and 'Ueber die Entwickelung der Schildkröten,' 4to, 1848, where he says, p. 105:—"Ausser den Rippen und den horizontal liegenden Tafeln, zu welchen sich die Dornfortsätze des zweiten und der sechs folgenden Rückenwirbel ausbilden, dienen bei den erwachsenen Schildkröten zur Zusammensetzung des Rückenschildes noch eine oder mehrere Knochenplatten," viz. the "marginal plates." I have shown how Rathké was deceived by over-estimating the character of connation, in my 'Observations on the Development of the Carapace and Plastron of the Chelonians,' which conduct to a different conclusion to that at which Cuvier and Rathké have arrived. (Philosoph. Transactions, 1849.)

† Geoffroy, Annales du Museum, tom. xiv (1809), p. 7.

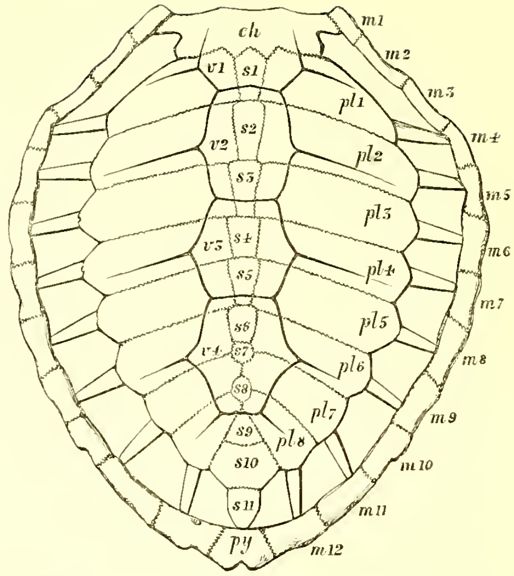
‡ This term is used in the definite sense explained in my work on the 'Archetype of the Vertebrate Skeleton' (8vo, V. Voorst, p. 49), as signifying those essentially different parts which are not physically distinct at any stage of development; and in contradistinction to the term "confluent," which applies to those united parts which were originally distinct.

§ See Griffiths's translation of Cuvier, vol. ix, Synopsis of Reptilia, p. 6—"fifth vertebral plates prominent."

‖ Anatome Testudinis Europææ, fol. 1821, tab. iii and iv.

and of a lateral series of "*costal scutes;*" there is also a peripheral series of "*marginal scutes*" corresponding with and impressing the marginal plates. The nuchal plate (*ch*) is remarkable for its breadth in all Chelonia, and usually sends down a ridge from the middle line of its under surface, which is attached by ligament to the summit of the neural arch of the first dorsal vertebra. The first true neural plate, *s*1, is much narrower, and is connate with the summit of the neural spine of the second dorsal vertebra; the succeeding vertebral neural plates, *s*2—*s*8, have the same relations with the succeeding neural spines, but the ninth, tenth, and eleventh, like the nuchal (*ch*) and pygal (*py*), plates are independent ossifications in the substance of the derm. The costal pieces of the carapace are supra-additions to eight pairs of pleurapophyses or vertebral ribs, those, viz. of the second to the ninth dorsal vertebræ inclusive. The slender or normal portions of the ribs project freely for some distance beyond the expanded and connate portions ("costal plates" of the carapace), along the under surface of which the rib may be traced, of its ordinary breadth, to the neck and head, which liberates itself from the costal plate to articulate to the interspace of the two contiguous vertebral bodies, (centrums), to the posterior of which such rib properly belongs.

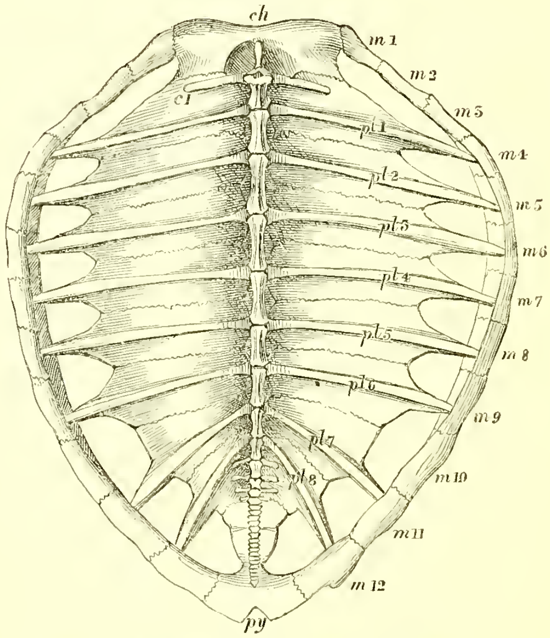
Fig. 1.



Carapace of the Loggerhead Turtle (*Chelone caouanna*).

The woodcut (fig. 2) illustrates this structure: *ch* shows the inner side of the nuchal plate; *c*1 is the first rib, articulated to the fore part of the body of the first dorsal vertebræ; *pl*1 is the first rib of the carapace (the second rib of the dorsal series), connate with the first costal plate; *pl*2 to *pl*8, are the succeeding ribs and costal plates of the carapace. The heads of the ribs articulate to

Fig. 2.



Inner view of carapace of the Loggerhead Turtle (*Chelone caouanna*).

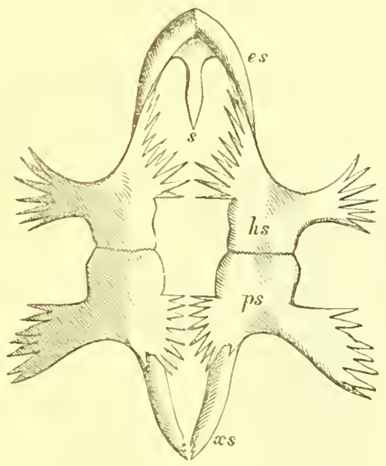
the interspaces between their own vertebral body, and that of the preceding vertebra. The tenth vertebra supports a short pair of ribs in *Chelone* and in *Emys*, but not in *Trionyx;* and this vertebra is commonly reckoned as a "lumbar" one. The eleventh and twelfth vertebræ have short and thick ribs, which abut against the iliac bones, and they are regarded as forming the sacrum. The remaining vertebræ belong to the tail, and are "caudal." The costal plates articulate with each other, and with the neural plates by fine dentated sutures. The free extremities of the ribs are implanted into sockets of those marginal plates which are opposite to them. The 1st, 2d, 3d, and 10th, are not so articulated in the loggerhead turtle. But all the marginal plates articulate with each other, and with the nuchal (*ch*) and pygal (*py*) plates by sutures.

The osseous basis of the plastron consists of nine pieces, one single and symmetrical, the rest in pairs.

The median piece, *s*, is the *entosternal;* the anterior pair, *es*, is the *episternal;* the second pair, *hs*, the *hyosternal;* the third pair, *ps*, the *hyposternal;* and the posterior pair, *xs*, the *xiphisternal*.

With regard to the nature or homologies of these bones, three views have been taken. The one generally adopted, on the authority of Cuvier, Bojanus, and Geoffroy St. Hilaire, is, that the nine bones of the plastron are subdivisions of a vastly expanded sternum, or breast-bone; the second view is, that these subdivisions of the sternum are enlarged by combination with ossifications of the integument;* and the third view, in which Rathké stands alone, is, that they are exclusively dermal bones, and have no homologues in the endoskeleton of other vertebrata.†

Fig. 3.



Bones of the plastron of the Loggerhead Turtle (*Chelone caouanna*).

Since this opinion is given as the result of that celebrated embryologist's observations on the development of the Chelonian reptiles, I have tested it by a series of similar researches on the embryos and young of the *Chelone mydas* and *Testudo indica*, and have been led by them to conclusions distinct from any of the three theories above cited.

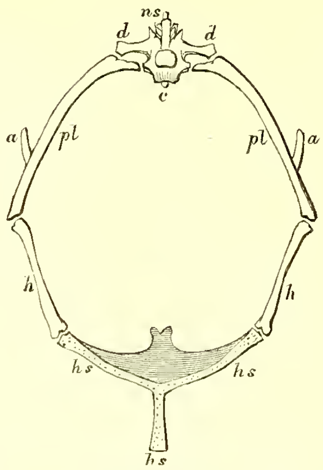
The sternum, like the carapace, is, without doubt, a compound of connate, endoskeletal and exoskeletal pieces; but the endoskeletal parts are not exclusively the homologues of the sternum. For the details of the observations, and the special arguments on which these conclusions are founded, I must refer to my paper in the 'Transactions of the Royal Society,' 1849; the homologies of the endoskeletal parts of the plastron will require a brief illustration here from comparative anatomy.

* Peters, Observationes ad Anatomiam Cheloniorum, 1838.

† Ueber die Entwickelung der Schildkröten, 4to, 1848, p. 122.

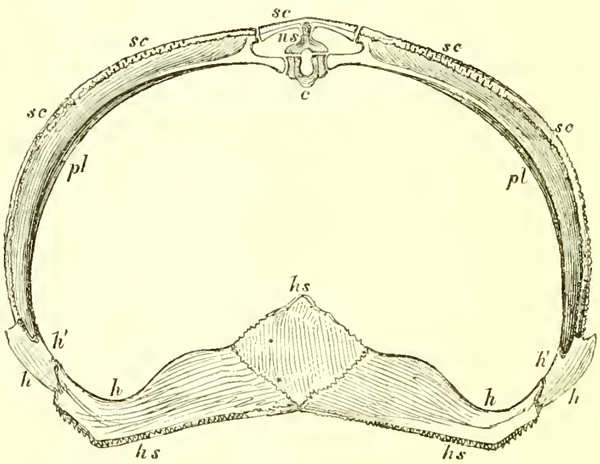
Geoffroy St. Hilaire, whose views are generally adopted, was guided in his determination of the parts of the plastron by the analogy of the skeleton of the bird: which analogy may be illustrated by the subjoined diagrams of corresponding segments of the thorax of a bird (fig. 4) and of a tortoise (fig. 5). In both figures *c* is the centrum or vertebral body; *ns* the neural arch and spine; compressed in the bird, depressed and laterally expanded, according to Geoffroy, in the tortoise; *pl* the pleurapophysis, or vertebral rib, expanded in the tortoise, and with its broad tubercle articulating with the expanded spine; *h*, *h'* in fig. 5, answers to *h* in fig. 4, and is the hæmapophysis (sternal rib, or ossified cartilage of the rib); *h*, *hs* in fig. 5, is *hs* in fig. 4, i. e. exclusively a sternum, with the entosternal piece, *hs'*, developed horizontally in the tortoise, and vertically in the bird. The *primâ facie* simplicity of this view has imposed upon most comparative anatomists: and yet there are other vertebrate animals more nearly allied to the *Chelonia* than birds, and with which, therefore, comparison should have been instituted before general consent was yielded to the Geoffroyan hypothesis. If, e. g. we take the segment of a crocodile's skeleton (fig. 6) corresponding with that of the tortoise (fig. 5), the comparison will yield the following interpretation: in both figures *c* is the centrum: *ns* the neural arch and spine, with *d* the diapophysis; *sc* a median dermal bony plate (connate with *ns* in the tortoise); *pl* the pleurapophysis; *sc sc* lateral dermal bony plates (connate with *pl* in the tortoise); *h*, *h'* in fig. 5, answers to *h'* in fig. 6, an intercalated, semi-ossified piece between *pl* and *h* in the crocodile; *h*, *hs* in fig. 5, answers to *h*, the hæmapophysis in the crocodile; and *hs* in fig. 5, exclusively represents *hs*, the sternum in the crocodile.

Fig. 4.



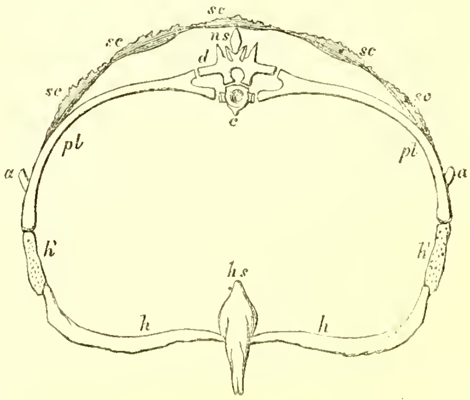
Thoracic segment of the skeleton of a Bird.

Fig. 5.



Thoracic segment of the skeleton of a Tortoise.

Fig. 6.



Thoracic segment of the skeleton of a Crocodile.

Such a comparison, in my opinion, guides us to a truer view of the homologies of the thoracic-abdominal bony case of the Chelonians, especially with regard to the lateral or parial pieces of the plastron, than the comparison exclusively relied on by Geoffroy St. Hilaire. The *Plesiosaurus*, by its long and flexible neck, small head, expanded coracoid and pubis, and flattened bones of the paddles, comes much nearer to the turtle than the crocodile does; and its abdominal ribs, or hæmapophyses, are more developed than in the crocodiles; a comparison of the ventral surface of the skeleton, such as that figured by Dr. Buckland, in his 'Bridgewater Treatise,' vol. ii, pl. 18, fig. 3, will show how clearly those abdominal ribs would correspond with the hyosternals and hyposternals of the turtle, if they had coalesced together at their middle parts, leaving their outer and inner extremities free.

With regard to the marginal pieces *m*1—*m*12, figs. 1 and 2, although the comparisons illustrated by figs. 4, 5, 6, show that they answer rather to the intercalated piece *h'* in the crocodile than to the entire sternal rib *h* in the bird; yet the phenomena of their development demonstrate that they are exclusively bones of the dermal skeleton, retaining their freedom from anchylosis with the endoskeletal elements, like the nuchal, pygal, and last three neural plates (*ch*, *py*, *s*9, *s*10, and *s*11, fig. 1). This insight into their true nature teaches why they do not correspond in number with the vertebral ribs or pleurapophyses (*pl*1—*pl*8, fig. 2). In the loggerhead turtle, for example, the first three and the tenth (*m*1, *m*2, *m*3, and *m*10) have no corresponding pleurapophyses articulating with them; and if even *c*1 be supposed to correspond to *m*3, there are no rudiments of ribs answering to *m*1 and *m*2. The marginal plates are not constant in number; the *Chelone mydas* has two less than the *Chelone caouanna* has. Some species of *Trionyx* (*Cryptopus*, Dum. and Bibron) have a greater number, but of smaller and less regular size, confined to the posterior part of the limb of the carapace; in other species of *Trionyx* (*Gymnopus*, Dum. and Bibron), and in *Sphargis*, the marginal part of the carapace retains its embryonic condition in all *Chelonia*, as a stratum of cartilaginous cells in the substance of the derm, forming the thickened, flexible border of the carapace.

The rudiments of the hyosternals and hyposternals have originally the form of sternal or abdominal ribs; extend transversely, and rise at their outer extremities to join those of the first and sixth pair of vertebral ribs, completing the hæmal, or inferior vertebral arch, without the interposition of any of the marginal pieces, which are merely applied to the outer sides of the hæmapophysis or sternal ribs. The expansion of the parts of the plastron, especially in the fresh-water and land tortoises, is due chiefly to the ossification of a layer of cartilage-cells in the substance of the derm, which ossified plates are connate with the more internal elements of the plastron, representing the sternum and sternal ribs. In the following descriptions of the fossil *Chelonia*, the terms 'entosternal, episternal, hyosternal, hyposternal,' and 'xiphisternal,' will be used as absolute designations of the combined endoskeletal and exoskeletal bones of the plastron, without implying assent to the hypothesis that first suggested those names to Geoffroy St. Hilaire.

The scapular and pelvic arches, and the bones of the extremities of the *Chelonia*, are described and figured in the 'Ossemens Fossiles' of Cuvier;* where, also, the figures of the modifications of the carapace and plastron, in the fresh-water and land tortoises, will suffice for the purpose of ulterior comparisons with the fossils described in the present work, if they be understood according to the homologies above discussed, and which are illustrated by the figures 1 and 2 of the carapace, and fig. 3 of the plastron of the *Chelone caouanna*.

With regard to the more immediate subjects of the present Monograph, it must be admitted that the important generalizations of Cuvier and Dr. Buckland† have been confirmed, but not materially extended, by subsequent observations on the remains of reptiles of the Chelonian order. Cuvier, after admitting that his results in regard to the tortoises were not so precise as those relating to the crocodiles, sums up his chapter on the fossil *Chelonia* in the following words: "Toutefois nous avons pu nous assurer que les tortues sont aussi anciennes dans le monde que les crocodiles; qu'elles les accompagnent généralement, et que le plus grand nombre de leurs débris appartenant à des sous-genres dont les espèces sont propres aux eaux douces ou à la terre ferme, elles confirment les conjectures que les os de crocodiles avoient fait naître sur l'existence d'iles ou de continens nourissant des reptiles, avant qu'il y ait eu des quadrupèdes vivipares, ou du moins avant qu'ils aient été assez nombreux pour laisser une quantité de débris comparable à ceux des reptiles."‡

Dr. Buckland also states, in general but precise terms, that "the Chelonian reptiles came into existence nearly at the same time with the order of *Saurians*, and have continued coextensively with them through the secondary and tertiary formations unto the present time. Their fossil remains present also the same threefold divisions that exist among modern *Chelonia* into groups, respectively adapted to live on land, in fresh water, or the sea."§

The remains of sea turtles (*Chelone*) have been recognised in the Muschelkalk, the Wealden, the lower cretaceous formation at Glaris, and the upper chalk-beds at Maestricht. Figures of Chelonites, as that in the Frontispiece to Woodward's 'Synoptical Table of British Organic Remains,' and in König's 'Icones Sectiles' (pl. xviii, fig. 232, *a* and *b*), have been published; but no true marine Chelonian, from Eocene strata, had been scientifically determined prior to the communication of my Paper on that subject to the Geological Society of London.‖ All the Chelonites from Sheppey, described and figured in the last edition of Cuvier's 'Ossemens Fossiles,' for

* Tom. v, pt. 2, pl. xii and xiii.

† Bridgewater Treatise (1836), p. 256.

‡ Ossemens Fossiles, 4to, tom. v, pt. ii, p. 249.

§ Bridgewater Treatise, p. 256.

‖ Proceedings of the Geological Society of London, vol. iii, pt. ii, p. 570, December 1, 1841.

example, are referred to the fresh-water genus *Emys;* and the statement in the earlier edition of the 'Ossemens Fossiles,' that the greater part of the remains of Chelonian reptiles belong to the fresh-water or terrestrial genera, is repeated.

The aim of the Memoir, communicated to the Geological Society in December, 1841, was to show that the conclusion deduced by Cuvier, from an imperfect carapace from Sheppey, which might probably have belonged to a species of *Emys*, had been unduly extended to other Chelonites, which undoubtedly belonged to the marine genus *Chelone;* and that this genus was represented, in the Eocene strata, by at least six species; the remains of five of which were from the London Clay at Sheppey, and those of a sixth were tolerably abundant in the cliffs near Harwich.

In the carapace of the fossil Chelonian from Sheppey, communicated by Mr. Crowe, of Faversham, to Cuvier, and figured in the 'Ossemens Fossiles' (tom. v, part 2, pl. xv, fig. 12), the author of that great work conceived that all the characters of the genus *Emys* were perfectly recognisable.

He points out the proportions of the neural plates, which are as long as they are large; and in the figure they are represented of nearly a quadrate form, and not rhomboidal.

The fifth neural plate in the fragment figured (probably the eighth) is separated from the sixth (ninth) by a point, which is made by the mesial ends of the fifth (probably the seventh) pair of costal plates; a structure which Cuvier says slightly recalls what he had observed in the Jura *Emys* of Soleure.*

But Cuvier admits that the neural plates (*plaques vertébrales*) are narrower than those of existing *Emydes;* and that the equal breadth of the ribs is a character common to the *Chelones* with the *Emydes.*

Now, in reference to the carapace figured by Cuvier, it is to be observed, that the margins are wanting; and that the broad conjoined portions of the costal plates are not longer than they might have been, had the fossil belonged to a turtle (*Chelone*); and, consequently, that there is no proof that they were united together by suture throughout their whole extent, as in the *Emydes;* but that they might have terminated in narrow tooth-like processes, as in the *Chelones.*

The narrowness of the neural plates is a character which, with their smoothness, undoubtedly approximates the fossil to the *Chelones;* and, without intending to affirm that the fossil in question does not belong to the family *Emydidæ,* which unquestionably existed at the time of the deposition of the Sheppey clay, its determination appears to me to be much less decisive than might be inferred from the remarks in the 'Ossemens Fossiles.'

* Tom. cit., p. 234. This structure is not, however, peculiar to the genus *Emys;* in the carapace of the *Chelone caouanna*, in the Museum of the Royal College of Surgeons, the seventh neural plate is separated from the eighth by the junction of the expanded extremity of the seventh rib on one side with that of the opposite rib, and the eighth neural plate from the ninth by the same modification of the eighth pair of ribs. A similar modification may also be seen in the carapace of the *Trionyx Henrici*, T. XVI.

Mr. Parkinson describes the plastron of a Sheppey Chelonite,* in which the hyosternal and hyposternal pieces are not united, but leave a vacancy in the middle, which he conjectured may have been filled up by membrane. This specimen must have belonged to a specimen at least four inches in length, exclusive of the head and neck. But Cuvier supposes that it may, nevertheless, have belonged to an *Emys;* and that the vacancy of the bony sternum merely indicated the nonage of the individual.†

The grounds on which Cuvier refers to the genus *Emys*, the imperfect and dislocated carapace and plastron of M. Bourdet's Sheppey Chelonite,‡ are not detailed; but it is evident that the hyposternals in that specimen are in contact at the posterior moiety of their median margins only; and that the margins recede anteriorly, leaving a median interspace; which, as the plastron is nearly a foot in length, can hardly be attributed to the immature state of the individual. And if, as Cuvier supposes, this specimen belongs to the same species as those in the collections of Messrs. Crowe and Parkinson, the same objection to their belonging to a fresh-water tortoise holds good, as to the one figured by M. Bourdet.

The question of the reference of these Eocene fossils to the fresh- or sea-water families of the Chelonian order, seems to me to admit of the safest determination by examining the crania of the Sheppey Chelonites; since the differences in the extent to which the temporal fossæ are protected by bone, and in the proportions in which the bones enter into the formation of that covering, are strongly marked in the genera *Emys* and *Chelone.*

But here Cuvier appears to have been unusually biassed in favour of the Emydian nature of the Sheppey fossils; for in reference to the cranium, figured by Mr. Parkinson, the affinities of which to the turtle's skull will be presently pointed out, Cuvier observes: "elle est probablement aussi d'une Emyde, bien qu'elle participe des caractères de Tortues de Mer, par la manière dont le parietal recouvre sa tempe; mais nous avons vu que *l'Emys expansa* diffère très peu de Tortues de Mer à cet égard, et la partie antérieure de la tête fossile ressemble d'avantage à celle d'une Emyde qu' à celle d'une Chelonée, surtout par le peu de largeur de l'intervalle des yeux."§

Now the most striking difference between the temporal bony vault of the *Emys expansa* and that of any known species of *Chelone*, is seen in the diminutive size of the post-frontals in this exceptional case among the *Emydes*, as contrasted with their large size and actual extension over the temporal fossæ in the *Chelones:*—and this difference is accompanied by a proportional diminution in the breadth of the parietals in the true marine turtles.

* Organic Remains, vol. iii, p. 268, pl. xviii, fig. 2.

† Ossemens Fossiles, tom. v, pt. ii, p. 235.

‡ Tom. cit., pl. xv, figs. 14-15.

§ Tom. cit., p. 235.

But the figure in Parkinson's work gives clearly the latter character; whence also we may infer that it agreed more with the *Chelones* also in the size of the postfrontals; although the anatomy of the skull is too obscurely delineated to demonstrate this fact.

The following important affinities are, however, unquestionably indicated in Parkinson's figure:—*first,* the large size of the orbits, which are nearly six times greater than those of the *Emys expansa; secondly,* their more posterior and lateral position; and *thirdly,* the greater breadth of the interorbital space: in all which characters the Sheppey fossil closely resembles the true *Chelones,* and differs from the only known species of *Emys* (*Podocnemys*) *expansa,* in which the temporal openings are protected by a bony roof.

That fresh-water tortoises have left their bony cuirasses in the Sheppey clay, will be subsequently shown; but the evidence of the genus *Emys,* adduced by Cuvier, is incompetent to prove their existence; and, it may be affirmed, that of the fossils cited by the founder of Palæontology, some, with great probability, and others with certainty, are referable to the marine genus, *Chelone.*

Without further discussing the question as regards these evidences, I shall proceed to describe the specimens from Sheppey which I have myself had the opportunity of examining; and shall commence with those which belong undoubtedly to the marine family.

CHELONE BREVICEPS. *Owen.* Tabulæ I and II.

Proceedings of the Geological Society, December 1, 1841; Report on British Fossil Reptiles, Trans. British Association, 1841, p. 178.

Syn. EMYS PARKINSONII. *J. E. Gray.*
— DE SHEPPEY. *H. v. Meyer* (?).
CHELONE ANTIQUA. *Kœnig* (?).

The first of the Chelonites, which led me to the recognition of this species, was a nearly perfect cranium from Sheppey (Tab. I, figs. 1—4), wanting only the occipital spine, and presenting a strong and uninterrupted roof, extended posteriorly from the parietal spine on each side (7, 7), over the temporal openings to the mastoids (8, 8); and formed anteriorly by a great development of the posterior frontals (22).

This unequivocal testimony of the marine genus of the fossil, is accompanied by similar evidence afforded by the large size and lateral aspect of the orbits, the posterior boundary of which extends beyond the anterior margin of the parietals; and by the absence of the deep emargination which separates the superior maxillary from the tympanic bone in the fresh-water tortoises, and especially in the *Podocnemys expansa.*

In general form, the skull of the present species of Sheppey *Chelone* resembles that of the *Chelone mydas,* BRONGN.: but it is relatively broader; the prefrontals (14) are less sloping, and the anterior part of the head is more vertically truncate. The orbits are relatively larger, and extend nearer to the tympanic cavity. The frontals (11) enter into the formation of the orbits in rather a larger proportion than in *Chelone mydas*. In the *Chelone caouanna** they are wholly excluded from the orbits.

The trefoil shape of the occipital tubercle is well marked (fig. 4); the depression in the basioccipital, bounded by the angular pterygoid ridges, is as deep as in most true turtles (fig. 3); the lateral borders of the expanded parietals are united by a straight suture along a great proportion of their extent to the large postfrontals.

These proportions are reversed in the *Podocnemys expansa*, in which the similarly expanded plate of the parietals is chiefly united laterally with the squamosal and tympanic bones. In other fresh-water tortoises the parietal plate in question does not exist.

The same evidence of the affinity of the Sheppey Chelonite in question to the marine turtles, is afforded by the base of the skull (fig. 3); the basioccipital (1) is deeply excavated; the processes of the pterygoids (24), which extend to the tympanic pedicles, are hollowed out lengthwise: the palatal processes of the maxillary and palatine bones are continued backwards to the extent which characterises the existing *Chelones;* and the posterior or internal opening of the nasal passages, is, in a proportional degree, carried further back in the mouth. The lower opening of the zygomatic spaces is wider in the present Sheppey Chelonite, than in *Podocnemys expansa.*

The external surface of the cranial bones in the fossil is roughened by small irregular ridges, depressions, and vascular foramina, which give it a wrinkled or shagreen-like character.

The following are dimensions of the specimen described:

	Inches.	Lines.
Length of cranium from the occipital condyle . . .	2	9
Breadth of cranium across the malars (26)	2	7
Antero-posterior diameter of orbit	1	0

The lower jaw, which is preserved in the present fossil, likewise exhibits two characters of the marine turtles; the dentary piece (32), *e. g.* forms a larger proportion of the lower jaw than in the land or fresh-water tortoises. The joint of the rami is completely obliterated at the symphysis, which is not longer or larger than in *Chelone mydas.*

The species represented by this fossil, which is preserved in the British Museum, and by a very similar one in the Hunterian Collection, is selected for the first of the Eocene Chelonians to be described in the present Monograph, because it is one of the few with which the characters of the carapace and plastron can with certainty be associated with those of the cranium.

* Ossem. Fossiles, tom. v, pt. ii, pl. xi, fig. 2.

In the rich collection of Sheppey fossils, belonging to J. S. Bowerbank, Esq. F.R.S. there is a beautiful Chelonite (Tab. II, figs. 1, 2) including the carapace, plastron, and the cranium, which is bent down upon the fore part of the plastron; and which, though mutilated, displays sufficient characters to establish its specific identity with the skull of the *Chelone breviceps* just described. Both the carapace and plastron present the same finely rugous surface externally as the cranium; in which character we may perceive a slight indication of affinity with the genus *Trionyx*.

The carapace (T. II, fig. 1) is long, narrow, ovate, widest at its anterior half, and tapering towards a point posteriorly; it is not regularly *convex*, but slopes away, like the roof of a house, from the median line (fig. 3), resembling, in this respect, and its general depression, the carapace of the turtle *Chelone mydas*. There are preserved the nuchal plate (fig. 1, *ch*) with ten of the neural plates (*n*1—*n*10), only the eleventh and pygal plates being wanting. The eight pairs of costal plates (*pl*1—*pl*8) are also present, with sufficient of the narrower tooth-like extremities of the six anterior pairs of ribs, to determine the marine character of the fossil, which is indicated by its general form.*

The nuchal plate (fig. 6, *ch*) is of a transversely oblong form, with the anterior margin gently concave. Its antero-posterior diameter, or length, is ten lines; its transverse diameter, or breadth, is two inches. The lateral margins are bounded by two lines meeting at a slight angle; to the anterior one, the first of the marginal plates, *m*1, is attached; the posterior line bounds part of the vacant interspace between the first costal plate (*pl*1), and the anterior marginal plate. The presence of this plate would prove for the genus *Chelone* as against *Trionyx*, were the characters of the cranium, the impressions of the vertebral scutes, and the sternum wanting. The nuchal plate in the *Emydes* is hexagonal, and nearly as long as it is broad.

The Chelonite from the tertiary beds near Brussels, figured by Cuvier,† has the nuchal plate of nearly the same form as the present specimen from Sheppey.

The neural plates in the *Chelone breviceps* are as narrow as in the *Chelones* generally; and as in the Brussels Chelonite above cited.

The first neural plate (*s*1, fig. 1) is four-sided; the rest, to the eighth (*s*8), are hexagons of a more regular figure than in the existing *Chelones*, and are articulated to more equal shares of the contiguous alternate costal plates (*pl*1—*pl*8).

The first costal plate (*pl*1) is directed more outwards, does not incline backwards, as in recent *Chelones*, and its anterior angle is less truncated than in them. (See fig. 1, p. 3.)

The length of the second costal plate (*pl*2) is one inch, nine lines; more than half of the narrow terminal extremity of the connate rib is preserved; the proportions of

* In an *Emys* with a carapace seven inches in length, the corresponding extremities of the ribs would have been united together by the laterally-extended ossification.

† Ossemens Fossiles, tom. v, pt. 2, pl. xv, fig. 16.

the remaining costal plates correspond with those of the *Chelone mydas,* and *Chel. caouanna.*

The last pair of costal plates (*pl*8) articulates with the eighth, ninth, and tenth neural plates, but does not overlap or supersede any of them.

Not any of the costal plates articulate with those of the opposite side, so as to interrupt the series of vertebral plates, as in the carapace of the *Chelone caouanna* (fig. 1, p. 3), as in Mr. Crowe's Sheppey Chelonite, figured by Cuvier (tom. cit. pl. xv, fig. 12); and as is shown in the view of the concave surface of the Brussels species (tom. cit. pl. xv, fig. 16).

The ninth neural plate (fig. 1, *s*9) is the narrowest, as in the *Chelones,* and as in the Brussels Chelonite, figured by Cuvier, in loc. cit. pl. xiii, fig. 8, instead of being suddenly expanded, as in most *Emydes.*

The tenth neural plate (*s*10) expands to a breadth equal with its length; the eleventh and pygal plates, as already observed, are wanting in the fossil.

The vertebral or median ends of the costal plates present a modification of form, corresponding with that of the interspaces of the neural plates to which they are articulated. Only the first pair (*pl*1) present that form which characterises all but the last pair in the existing *Chelones,* and in the Brussels Chelonite; viz., a straight line with the posterior angle cut off; the rest being terminated by two nearly equal oblique lines, meeting at an open angle, as shown in Tab. II, fig. 1, *pl*2—*pl*7.

This character would serve to distinguish the *Chelone breviceps*, if only a portion of the carapace, including the vertebral extremity of a rib, were preserved. The free extremities of the ribs are thicker in proportion to the costal plates, than in the *Chelone caouanna,* or the *Chel. mydas;* and more resemble, in this respect, those of the *Chel. imbricata,* the species characterised by the size and beauty of the horny scutes, commonly called "tortoise-shell."

More or less complete impressions of the five horny vertebral scutes (*v*1—*v*5), and of four costal scutes on each side of the vertebral ones, show the forms and proportions of these characteristic parts, and especially of the median series, notwithstanding they were among the soluble and perishable elements of this ancient turtle of the Thames.

The hexagonal vertebral scutes are characterised by the near equality of their sides, and the angle of about 100°, at which the two outer sides meet.

The anterior border of the first vertebral scute, v^1, has crossed and impressed the nuchal plate, *ch,* near its anterior border; this scute has covered the rest of the nuchal plate, and more than half of the first neural plate. The second vertebral scute, v^2, includes the rest of the first neural plate, the whole of the second, and almost the whole of the third neural plate. The third vertebral scute, v^3, includes the hind border of the third neural plate, with the whole of the fourth and fifth neural plates. The fourth vertebral scute includes the sixth and seventh, and very nearly the whole of the eighth neural plates, and the outer angles of this scute terminate over the suture between the sixth and seventh costal plates.

The plastron of the *Chelone breviceps* (Tab. II, fig. 2), although more ossified than in existing *Chelones,* yet presents all the essential characters of that genus. There is a central vacuity left between the hyosternals (*hs*) and hyposternals (*ps*); but these bones differ from those of the young *Emys* in the long pointed processes which radiate from the two anterior angles of the hyosternals (*hs*), and the two posterior angles of the hyposternals (*ps*).

The xiphisternals (*xs*) have the slender elongated form, and oblique union by reciprocal gomphosis with the hyposternals (*hs*), which is characteristic of the genus *Chelone.*

The posterior extremity of the right episternal (*es*) presents the equally characteristic, slender pointed form.

With these proofs of the modification of the plastron of the present fossil according to the peculiar type of the marine *Chelones,* there is evidence, however, that it differs from the known existing species in the more extensive ossification of the component pieces; thus the pointed rays of bone extend from a greater proportion of the margins of the hyosternals and hyposternals; and the intervening margins do not present the straight line at right angles to the radiated processes.

In the *Chelone mydas,* and *Chel. caouanna* (fig. 3, p. 4), for example, one half of the external margin of the hyosternal and hyposternal, where they are contiguous, are straight, and intervene between the radiated processes, which are developed from the remaining halves, while in the *Chelone breviceps,* about a sixth part only of the corresponding external margins are similarly free, and there form the bottom, not of an angular, but a semicircular interspace.

The radiated processes from the inner margins of the hyosternals and hyposternals, are characterised in the *Chelone breviceps* by similar modifications, but their origin is rather less extensive; they terminate in eight or nine rays, shorter, and with intervening angles more equal than in existing *Chelones.* The xiphisternal piece, *xs,* receives in a notch the outermost ray or spine of the inner radiated process of the hyposternal, as in the *Chelones,* and is not joined by a transverse suture, as in the *Emydes,* whether young or old.

Subjoined are dimensions of the plastron of Mr. Bowerbank's fossil:

	Inches.	Lines.
Shortest longitudinal diameter of hyosternal and hyposternal pieces	2	5
Transverse diameter of ditto	1	7
Total length of plastron	6	0

The bones of the scapular arch, especially the coracoid, Cuvier has shown to afford distinctive characters of the natural families of the *Chelonia;* but the Eocene Chelonites described by Cuvier, did not yield him this opportunity of thus testing their affinities. In the *Chelone breviceps* here described, the left coracoid (52, fig. 2) is preserved in nearly its natural position; it is long, slender, symmetrical; cylindrical near its humeral extremity; flattened, and gradually expanded from its humeral third, to its sternal end, which is relatively somewhat broader than in the *Chelone mydas* and *Chelone caouanna*.

	Inch.	Lines.
Its length is	1	6
Breadth of sternal end . . .	0	7

The characters thus afforded by the cranium, carapace, plastron, and by one of the bones of the anterior extremity, prove the present Sheppey fossil to belong to a true sea turtle; and at the same time most clearly establish its distinction from the known existing species of *Chelone*.

On account of the shortness of the skull, especially of the facial part and of that which intervenes between the orbit and ear, compared with the breadth of the skull across the mastoids, I have proposed to name this extinct species, *Chelone breviceps*.*

By the characteristic shape of the median extremities of the costal plates of the carapace, I have been able to determine some fragmentary Chelonites which have afforded better ideas of the size of the species represented by Mr. Bowerbank's more complete but immature specimen of *Chelone breviceps*.

A portion of the carapace of the *Chelone breviceps*, including the fourth, fifth, sixth, and part of the third and seventh neural plates, with a considerable proportion of the third, fourth, fifth, and sixth costal plates, is preserved in the museum of Mr. Robertson, of Chatham. The characters of the rugous surface of these bones, and of the equal-sided angles by which the costal plates articulate with the neural plates, do both, and especially the latter, point out the species to which the present fragment belongs. It has formed part of an individual double the size of the specimen above described, and figured from Mr. Bowerbank's collection, and therefore it had a carapace sixteen inches in length.

Although the costal plates have been continued further along the ribs than in the younger example, the more complete state of the sixth rib, in Mr. Robertson's specimen, shows that they retained their longitudinally-striated, tooth-like extremities, which, in the sixth rib, is two thirds of an inch in length; the length of the expanded part being four inches, and its breadth one inch nine lines. The internally prominent part of the rib is much less developed than in *Chelone planimentum*, and *Chelone crassicostata*, afterwards to be described. The right hyosternals and hyposternals are present, and they likewise preserve the character of the *Chel. breviceps* in their rugous surface and minor breadth, as compared with those parts in the *Chelone longiceps*, the extinct species next to be described.

Besides the specimens above described, on which the present extinct species of turtle

* Proceedings of Geological Society, December 1, 1841, p. 570. Report on British Fossil Reptiles, Trans. Brit. Association, 1841, p. 178.

has been established, remains of the *Chelone breviceps* are preserved in the Hunterian Museum, and in that of my esteemed friend and coadjutor, Professor Bell, S.R.S.

I know no other locality of the species than that of Sheppey, in Kent.

CHELONE LONGICEPS. *Owen.* Tab. III, IV, and V.

Proceedings of Geological Society of London, December 1, 1841, p. 572. Report on British Fossil Reptilia, Trans. British Association, 1841, p. 177.

The second species of *Chelone*, from the Eocene clay at Sheppey, which I originally recognised and defined by the fossil skull, Tab. III, differs more from those of existing *Chelones* by the regular tapering of that part into a prolonged pointed muzzle, than does the *Chelone breviceps* by its short and anteriorly-truncated cranium.

The surface of the cranial bones is smoother than in the *Chel. breviceps;* whilst their proportions and relations prove the marine character of the present fossil as strongly as in that species.

The orbits (Tab. III, figs. 1 and 2, *o*,) are large; the temporal fossæ (ib. fig. 3, *t*,) are covered principally by the posterior frontals (fig. 2, 12); and the osseous shield completed by the parietals (7), and mastoids (8), overhangs the tympanic (28), ex-occipital (2), and paroccipital (4) bones. The compressed spine (3) of the occiput is the only part that projects further backwards.

The palatal and nasal regions of the skull afford further evidence of the affinities of the present Sheppey Chelonite to the true turtles. The bony palate (fig. 3) presents, in an exaggerated degree, the great extent from the intermaxillary bones to the posterior nasal aperture which characterises the genus *Chelone;* and it is not perforated, as in the soft turtles (*Trionyx*), by an anterior palatal foramen.

The extent of the bony palate is relatively greater than in the *Chelone mydas,* and the trenchant alveolar ridge is less deep; the groove for the reception of that of the lower jaw is shallower than in the *Chelone mydas,* or the extinct *Chel. breviceps,* arising from the absence of the internal alveolar ridge, in which respect the *Chel. longiceps* resembles the *Chel. caretta.*

The *Chelone longiceps* is distinguished from all known existing *Chelones* by the proximity of the palatal vomer (13, fig. 3), to the basisphenoid (5), and by the depth of the groove of the pterygoid bones (24), and in both these characters in a still greater degree from the Trionyxes; to which, however, it approaches in the elongated and pointed form of the muzzle, and the trenchant character of the alveolar margin of the jaws.

The following are dimensions of the skull described:

	Inches.	Lines.
Length of the skull	4	0
Breadth of ditto across the zygomata	2	6
Antero-posterior diameter of orbit	1	2

In a second example of the skull of *Chelone longiceps*, two of the middle neural plates, and the corresponding costal plates of the right side, portions of vertebræ, with the right xiphisternal piece, humerus and femur, are cemented together, and to the cranium by the petrified clay. (T. IV, fig. 1.)

The neural plates (*s*2, *s*3) are flat and smooth; the entire one measures one inch two lines in length, and nine lines across its broad anterior part :—this receives the convex posterior extremity of the preceding plate in a corresponding notch. A small proportion, about one sixth, of the anterior part of the external margin, joins the second costal plate (*pl*2) ; the remaining five sixths of the outer margin forms the suture for the vertebral end of the third costal plate (*pl*3).

In this respect, the *Chel. longiceps* resembles the existing *Chelones ;* and differs, as well as in the smooth and flattened surface of the vertebral plates, from the *Chelone breviceps.* The length of the third costal plate, in the fragmentary example here described, is three inches ; the impression of the commencement of the narrow portion, formed by the extremity of the coalesced rib, is preserved.

The marginal indentations of the vertebral scutes are not half a line in breadth.

The transverse impression between the first and second vertebral scute crosses the first neural plate, nine lines from its posterior extremity ; the second neural plate is free, as in other *Chelones,* from any impression, being wholly covered by the second vertebral scute.

The expanded ribs are convex at the under part, slightly concave at the upper part in the direction of the axis of the shell ; they slope very gently from the plane of the neural plates, about half an inch, for example, in an extent of three inches ; thus indicating a very depressed form of carapace.

The xiphisternal bone (*xs*), like that of *Chel. breviceps,* is relatively broader than in the existing turtles, and both the internal and external margins of its posterior half are slightly toothed. A part of the notch by which it was attached to the hyposternal remains upon the broken anterior extremity of the bone. It measures one inch two lines across its broadest part ; its length seems to have been three inches and a half.

The humerus presents the usual characters of that of the *Chelones ;* its length is two inches three lines ; its breadth across the large tuberosities ten lines. The radius and ulna extend in this Chelonite from beneath the carapace into the right orbit ; the radius is one inch and a half in length ; the ulna one inch, three lines in length ; portions of vertebræ adhere also to the mass, the state of which indicates that the animal had been buried in the clay before the parts of the skeleton had been wholly disarticulated by putrefaction.

A mass of Sheppey clay-stone supporting the ninth and tenth neural plates, and the expanded portions of the sixth, seventh, and eighth costal plates of the right side, exhibits the characters of the marine turtles in the great relative expansion of the tenth neural plate; and the tooth-like continuation of the rib from the posterior angle of the eighth costal plate (*pl* 8, T. IV, fig. 2). These portions of the carapace, from their smooth surface, the impressions of the horny scutes, the form of the vertebral ends, and the concavity of the upper surface of the costal plates, evidently belong to the same species as the fossil last described.

A similar mass of Sheppey clay-stone, in Mr. Lowe's collection, supports a larger proportion of the hinder part of the carapace, including the sixth, seventh, eighth, ninth, and tenth neural plates, part of the fifth neural plate, more or less of the last four pairs of costal plates, with the impressions of the third and fourth ribs of the right side; the impression of apparently the whole of the free, slender, termination of the third rib is preserved, and also that of the fifth rib, confirming the generic characters indicated by the skull. The smooth outer surface of the bones of the carapace, the forms of the neural plates, and the concomitant modification of the commencement of the costal plates articulated therewith, concur to establish the specific distinction from the *Chelone breviceps*, and indicate the specimen to belong to the present species, *Chelone longiceps*. The seventh, eighth, and ninth neural plates progressively decrease in size; and the ninth presents a simple, quadrangular, oblong form; the tenth neural plate suddenly expands, and has apparently a triangular form, but its posterior border is incomplete.

The indications of the comparative flatness of the carapace of the *Chelone longiceps*, (in this respect, as in the elongated and pointed form of the skull, approaching the genus *Trionyx*,) which were derived from an examination of the foregoing fragments, and particularly of the portion preserved with the cranium on which the species is founded, are fully confirmed by the almost entire carapace which, subsequently to the publication of my 'Report on British Fossil Reptiles,' where the present species is first noticed, I have had the opportunity of examining in the collection of Mr. Bowerbank.

This carapace, as compared with that of the *Chelone breviceps* in the same collection, presents the following differences:—it is much broader and flatter. The neural plates are relatively broader; the lateral angle from which the intercostal suture is continued, is much nearer the anterior margin of the plate—the *Chelone longiceps*, in this respect, resembling the existing species of turtle (see fig. 1, p. 3). The costal plates are relatively longer; they are slightly concave transversely to their axis on their upper surface, while in *Chel. breviceps* they are flat. The external surface of the whole carapace is smoother; and although it is as depressed as in most turtles, it is more regularly convex; not sloping away by two nearly plane surfaces from the median longitudinal ridge of the carapace.

The following minor differences may be noticed in the two Sheppey Chelonites: the nuchal plate of the *Chel. longiceps* (Tab. V, fig. 1, *ch*) is more convex at its middle part, and sends backwards a short emarginate process to join the first neural plate ($s1$); in which it resembles the *Chel. mydas.* Both posterior angles of the first neural plates are produced, and truncate to articulate with the second pair of costal plates; and the second neural plate is quadrangular. In a portion of another carapace of the *Chelone longiceps* the second neural plate ($s2$) is pentangular, the right anterior corner being produced, and truncate to join with the first costal plate of the right side; the left posterior corner of the first neural plate ($s1$) being produced, and truncate, to articulate with the second costal plate of the left side. This structure I believe, however, to be an individual variety. But the characters of the species are exemplified in more constant modifications of the carapace. The succeeding neural plates to the seventh inclusive ($s3$—$s7$) are hexagonal, with the anterior lateral border much shorter than the posterior lateral border, as in *Chelone mydas,* and not of equal extent, as in *Chelone breviceps;* they become more equal in the seventh and eighth neural plates, which also decrease in size; the ninth plate ($s9$) is very small, quadrangular, and oblong, as in Mr. Lowe's fragment. Only a small portion of the tenth neural plate is preserved in Mr. Bowerbank's beautiful specimen.

The impressions of the horny scutes are deeper, and the lines which bound the sides of the vertebral scutes ($v1$—$v4$) meet at a much more open angle than in the *Chel. breviceps*, in which the vertebral scutes have the more regular hexagonal form of those of the *Chel. mydas.* Their relations to the neural plates are nearly the same as in *Chel. breviceps.*

The plastron (Tab. V, fig. 2) is more remarkable than that of the *Chel. breviceps* for the extent of its ossification; the central cartilaginous space being reduced to an elliptical or subquadrangular fissure. The four large middle pieces *hyosternals* (*hs*) and *hyposternals* (*ps*), have their transverse extent relatively much greater as compared with their antero-posterior extent, than in the *Chel. breviceps;* and this might be expected, in conformity with the broad character of the bony cuirass indicated by the carapace. The median margins of the *hyosternals* (*hs*) are developed in short toothed processes, along their anterior three fourths; the median margins of the *hyposternals* (*ps*) have the same structure along nearly their whole extent; the intermediate space between the smooth or edentate margins of the opposite bone is ten lines; the expanded end of the long coracoid (52) is seen projecting into this space.

The xiphisternals (*xs*) are relatively broader than in *Chel. breviceps*, or in any of the existing turtles; and are united together, or touch each other, by the toothed processes developed from the whole of their median margins. The entosternal piece is broad, flat on its under surface, and is likewise dentated at its sides.

The outer surface of each half of the plastron inclines, as in the *Chelone mydas,* towards a submedian longitudinal ridge.

The breadth of the plastron, in the specimen figured (fig. 2), along the median suture, uniting the hyosternals and hyposternals, is six inches: the narrowest antero-posterior diameter of the conjoined hyosternals and hyposternals is two inches nine lines.

The breadth of the plastron, at the junction of the xiphisternals with the hyposternals, is two inches six lines.

The posterior part of the cranium is preserved in Mr. Bowerbank's specimen (fig. 1), withdrawn beneath the anterior part of the carapace; the fracture shows the osseous shield covering the temporal fossæ; and the pterygoids remain, exhibiting the deep groove that runs along their under part.

It is most satisfactory to have found that the two distinct species of the genus *Chelone*, determined, in the first instance, by the skulls only, should thus have been confirmed by the subsequent comparison of their bony cuirasses; and that the specific differences, manifested by the cuirasses, should be proved by good evidence to be characteristic of the two species founded on the skulls.

Thus the portion of the skull preserved with the carapace first described (Tab. II, figs. 2 and 3), served to identify that fossil with the more perfect skull of the *Chelone breviceps* (Tab. I), by which the species was first indicated. And, again, the portion of the carapace adhering to the perfect skull of the *Chelone longiceps* (Tab. IV, fig. 1) equally served to connect with it the nearly complete osseous buckler (Tab. V, fig. 1), which, otherwise, from the very small fragment of the skull remaining attached to it, could only have been assigned conjecturally to the *Chel. longiceps;* an approximation which would have been the more hazardous, since the *Chelone breviceps* and *Chelone longiceps* are not the only turtles which swam those ancient seas that received the enormous argillaceous deposits of which the Isle of Sheppey forms a part.

CHELONE LATISCUTATA. *Owen.* Tab. VI.

Proceedings of the Geological Society of London, December 1, 1841, p. 574. Report on British Fossil Reptiles, Trans. British Association, 1841, p. 179.

A considerable portion, measuring three inches in length, of the bony cuirass of a young turtle from Sheppey, including the first to the sixth neural plates (T. VI, fig. 1, *s*1—*s*6), with the corresponding pairs of costal plates (*pl*1—*pl*6), and the hyosternal (fig. 2, *hs*) and hyposternal (*ps*) elements of the plastron, most resembles that of the *Chelone longiceps* in the form of the carapace, and especially in the great transverse extent of the above-named parts of the plastron: it differs, however, from the *Chel. longiceps*, and the other known fossil Chelonites, in the greater relative breadth of the vertebral scutes (*v*2, *v*3), which are nearly twice as broad as they are long.

The central vacuity of the plastron is subcircular; and, as might be expected, from the apparent nonage of the specimen, is wider than in the *Chel. longiceps;* but the toothed processes given off from the inner margin of both hyosternals and hyposternals are small, sub-equal, regular in their direction, and thus resemble those of the *Chel. longiceps;* the slender point of the episternal (*s*) is preserved in the interspace between the hyosternals. Both hyosternals (*hs*) and hyposternals (*ps*) are slightly bent upon a median longitudinal prominence of their under surfaces.

The length of the third costal plate (*pl*3) is one inch seven lines; its antero-posterior diameter or breadth, six lines: in the form of the vertebral extremities of the costal plates, and of the neural plates to which they are articulated, the present fossil resembles the *Chel. longiceps;* but the fifth neural plate is more convex, and is crossed by the impression dividing the third vertebral scute (*v*3) from the fourth, which impression crosses the suture between the fifth and sixth neural plates in both *Chelone longiceps* and *Chelone breviceps.* Whether, in the progressive change of form, which the vertebral scutes may have undergone in the growth of this young turtle, as during the growth of the young loggerhead turtle (*Chelone caouanna*), by an increase of length, without corresponding increase of breadth, the impression between the third and forth vertebral scute, might also retrograde to the interval between the fifth and sixth neural plates, I am uncertain, having only had the opportunity of comparing the scutes of the young and old loggerhead turtles, not the skeletons. The change in the lateral angles of the vertebral scutes, resulting from the elongation of the scutes themselves, in the loggerhead, would be similar to that in the *Chelone longiceps,* as compared with the *Chel. latiscutata,* on the hypothesis that the latter is the young of the former; but in my present uncertainty I prefer to indicate the specimen in question, by the definite name proposed in my original Memoir; its description as a distinct species being more likely to attract the attention of Collectors to similar specimens, and to enable them to identify such. Figure 3, T. VI, gives the degree of convexity of the carapace, and the double curve of the plastron produced by the prominence of the principal hæmapophyses *hs* and *ps.* The left scapular arch (51) is exposed in this view.

Chelone convexa. *Owen.* Tab. VII.

Proceedings of the Geological Society of London, December 1, 1841, p. 575. Report on British Fossil Reptiles, Trans. British Association, 1841, p. 178.

The fourth species of *Chelone,* indicated by a nearly complete cuirass, from Sheppey, holds a somewhat intermediate position between the *Chelone breviceps* and the *Chelone longiceps;* the carapace being narrower, and more convex than that of *Chel. longiceps;* broader and with a more regular transverse curvature than in the *Chelone breviceps.*

Although the specimen is equal in size to either of the two with which it is here compared, the costal plates hold an intermediate length, which shows that this character is not due to a difference depending upon age.

The fossil in question includes the first to the eighth neural plate inclusive; the first plate (*s*1) expands behind, and both posterior angles are truncated to articulate with the second costal plates (*pl*2). The second neural plate (*s*2) is quadrate, half as long again as broad, and the second pair of costal plates articulate with this, as well as with the first and third plates, as in the *Chel. longiceps* (Tab. V, fig. 1). The tooth-like extremity of the connate rib is preserved on the right side. The fourth costal plate (*pl*4) is two inches four lines in length, nine lines in breadth; the angle at which the expanded part contracts to the extremity of the connate rib is well shown on the right side. The third to the eighth neural plates expand anteriorly, and have the anterior angles cut off to articulate with the costal plates in advance; they diminish in size very gradually, and the antero-lateral borders, formed by the above-named truncated angles, do not increase in length as in the corresponding plates in the *Chelone longiceps*.

The vertebral scutes (*v*2, *v*3, *v*4) resemble more in form those of the *Chel. longiceps* than of *Chel. breviceps*; but, notwithstanding that the whole carapace is narrower than in *Chel. longiceps*, the vertebral scutes are broader; and the lines which converge to the lateral angle have a more marked sigmoid curvature.

	Chel. convexa.		*Chel. longiceps.*	
	Inches.	Lines	Inches.	Lines.
The length of the second vertebral scute is	1	8	1	8
Breadth	2	6	2	2

The two succeeding scutes (*v*3 and *v*4) more rapidly diminish in size than in either the *Chel. breviceps* or *longiceps*, and the transverse impression between the third and fourth vertebral scute crosses the lower third of the fifth neural plate, as in *Chelone latiscutata*. All the scutes have left deeper and rather wider impressions than in the preceding species.

The second to the fifth costal plates inclusive, are more equal in length than in the existing *Chelone mydas* or *Chel. caouanna*, and in this character the present species more resembles the *Chel. imbricata*.

The distinction of the present from the previously described fossils, already manifested in the structure of the carapace and the form of the vertebral scutes, is more strikingly established in that of the plastron (Tab. VII, fig. 2), which, in its defective ossification, resembles the same part in the existing species of *Chelone*.

All the bones, but especially the xiphisternals (*xs*), are more convex on their outer surface than in other turtles, recent or fossil. The central vacuity is greater than in any of the above-described fossil species. The internal rays of the hyosternals come off from the anterior half of their inner border, and are divided into two groups: the lower consisting of two short and strong teeth, projecting inwards towards the extremity of the entosternal (*s*); while the rest extend forwards along the inner side of episternals (*es*). The same character may be observed in the corresponding processes of the *hyposternals* (*ps*), which are limited to the posterior half of their inner border. The external radiated process of the hyosternals (*hs*) arises from a larger proportion of the outer margin, than in the *Chel. mydas*; but from a somewhat less proportion than in *Chel. breviceps*.

The external process of the hyposternal (*ps*) is relatively much narrower than in the *Chel. breviceps* (T. II, fig. 2), and, *à fortiori*, than in *Chel. longiceps* (Tab. V, fig. 2). The straight transverse suture by which the hyosternals and hyposternals of the same side are joined together, is much shorter than in the other fossil *Chelones;* and is similar in extent to that in *Chel. mydas;* but the following differences present themselves in the plastron of the *Chelone convexa*, as compared with that of the *Chelone mydas.*

The median margin of the hyosternals forms a gentle curve, not an angle: that of the hyposternals is likewise curved, but with a slight notch. The longitudinal ridge on the external surface is nearer the median margin of the *hyosternals* and *hyposternals* and is less marked than in the *Chelone longiceps;* especially in the hyposternals, which are characterised by a smooth concavity in the middle of their outer surface.

The suture between the *hyosternals* and *hyposternals* is nearer to the external, transverse, radiated process of the hyposternals. The median vacuity of the sternal apparatus is elliptical in the *Chel. convexa*, but square in the *Chel. mydas.*

The characteristic lanceolate form of the episternal bone (*s*) in the genus *Chelone*, is well seen in the present fossil. The entosternal element of the plastron is sub-circular, or lozenge-shaped; and generally broader than it is long in the Emydians.

The true marine character of the present Sheppey Chelonite, so well given in the carapace and plastron, is likewise satisfactorily shown in the small relative size of the entire femur (65) which is preserved on the left side, attached by the matrix to the left xiphisternal. It presents the usual form, and slight sigmoid flexure, characteristic of the *Chelones;* it measures one inch in length.

In an *Emys* of the same size, the femur, besides its greater bend, is one inch and a half in length.

A Chelonian cranium from Sheppey, two inches five lines in length, in the museum of Professor Bell (T. VI, fig. 4), and a second of the same species from the same locality, two inches nine lines in length, in the museum of Fred. Dixon, Esq., F.G.S., of Worthing, belong to the same species, and differ from the cranium of the *Chelone breviceps*, in the more pointed form of the muzzle, and the less rugose character of the outer surface of the bones; they equally differ from the *Chelone longiceps* in the less produced, and less acute muzzle, and the more rugose surface of the bones. The parietals (7) are bounded anteriorly by a semicircular line, not by a semioval one, as in *Chel. longiceps*, or by an angular one, as in *Chel. breviceps.* The frontals (11) enter into the formation of the orbits, as in both the foregoing species. The orbits are subcircular, as in *Chel. longiceps*, not subrhomboidal with the angle rounded off, as in *Chel. breviceps.* The postfrontals (12) are large, and form a slight projection at the back part of the supraorbital ridge. The tympanic cavity is larger in proportion than in the *Chelone longiceps.* The palate is traversed by a deep median, longitudinal groove, between which and the shallower grooves on the inner sides of the alveolar borders, are two well-marked, diverging, longitudinal prominences. The bony palate is longer than in *Chelone breviceps*, shorter than in *Chel. longiceps*. The symphysis of the lower jaw (T. VII, fig. 3) is longer or deeper than in the *Chelone breviceps*, but is convex below from side to side, and not flattened as in the *Chelone planimentum*.

All the specimens of *Chelone convexa*, which I have been able to determine, are from the London clay of Sheppey.

CHELONE SUBCRISTATA. *Owen.* Tab. VIII.

Proceedings of the Geological Society of London, December 1, 1841, p. 576. Report on British Fossil Reptiles, Trans. British Association, 1841, p. 179.

The fifth species of *Chelone* from Sheppey, distinguishable by the characters of its carapace, approaches more nearly to the *Chelone caouanna* in the form of the vertebral scutes (*v*1—*v*4), which are narrower in proportion to their length, than in any of the previously described species; but the *Chelone subcristata* is more conspicuously distinct by the form of the fifth and seventh neural plates (*s*5, *s*7), each of which supports a short, sharp, longitudinal crest; a similar crest is developed from the contiguous ends of the second and third neural plates (*s*2, *s*3); the middle and posterior part of the nuchal plate (*ch*) is raised into a convexity, as in the *Chel. longiceps;* but not into a crest.

The keeled structure of the above-cited neural plates is more marked than in the third and fifth neural plates of *Chelone mydas*, which are raised into a longitudinal ridge.

The neural plates in the present carapace have the ordinary, narrow, elongated form of those in the true *Chelones*. The nuchal plate (*ch*) has the middle of its hinder border produced backwards, instead of being emarginate, as in the *Chel. breviceps* (T. II, fig. 1, *ch*).

The first neural plate in the *Chelone subcristata* (T. VIII, *s*1) resembles that in the *Chelone convexa*, but is narrower in proportion to its length; the second (*s*2) is also quadrangular, as in *Chel. convexa*, but is narrower; the third to the seventh likewise differ from those in *Chel. convexa* only by being narrower; but the eighth and ninth neural plates are relatively smaller than in any of the before-described fossils, and resemble those of existing *Chelones*. The expanded plate is more elevated, and is bent down on each side, with the middle part forming an obtuse longitudinal ridge. A part of the contiguous portion of the first (*pl*1) and the second (*pl*2) costal plates are raised into a slight convex eminence on each side; the surface of the remaining pairs of ribs is flat in the axis of the body, but they are more convex transversely to that axis, and in the direction of their own length, than in the other Chelonites.

The whole outer surface of the bones of the carapace is as smooth as in the *Chel. longiceps* and *Chel. convexa*.

Length of carapace from the first to the eighth neural plate inclusive:

Ch. subcristata.		*Ch. breviceps.*		*Ch. longiceps.*		*Ch. convexa.*	
Inches	Lines.	Inches	Lines.	Inches.	Lines.	Inches.	Lines.
7	4	5	6	5	9	5	8

The length of the present fossil carapace, to the tenth neural plate, inclusive, is nine inches.

The breadth between the ends of the third costal plates, in a straight line, is six inches six lines. The succeeding costal plates more gradually decrease in breadth, than in the *Chel. longiceps* and *Chel. convexa;* and the entire carapace more resembles in form that of the *Chel. mydas,* and *Chel. caouanna.*

The epidermal scutes are defined by deep impressions, and as wide, relatively, as in the *Chel. mydas* and *Chel. convexa.* The length of the second vertebral scute is two inches one line; its breadth is two inches two lines; the length of the fourth vertebral scute is two inches three lines; and its breadth one inch eleven lines, and, at its posterior margin, only nine lines. This scute is narrower than in *Chel. caouanna*, or any of the previously described fossil species; the outer angles are less produced than in the *Chelone caouanna.*

Sufficient of the plastron is exposed in the present fossil to show by its narrow elongated xiphisternals (*xs*), and by the wide and deep notch in the outer margin of the conjoined hyosternals and hyposternals (*hs* and *ps*), that it belongs to the marine *Chelones.* The xiphisternals are articulated to the hyposternals by the usual notch or gomphosis; they are straighter and more approximated than in the *Chel. mydas* and *Chel. caouanna.* The external emargination of the plastron between the hyosternals and hyposternals, differs from that of the recent turtles in being semicircular, instead of angular; the *Chel. subcristata* approaching, in this respect, to the *Chel. breviceps.* The shortest antero-posterior diameter of the conjoined hyosternals and hyposternals is two inches seven lines. The length of the xiphisternal is two inches six lines; the breadth of both, across their middle part, is one inch three lines.

The name proposed for this species indicates its chief distinguishing character, viz., the median interrupted carina of the carapace, which may be presumed to have been more conspicuous in the horny plates of the recent animal, than in the supporting bones of the petrified carapace.

CHELONE PLANIMENTUM. *Owen.* Tab. IX and X.

Proceedings of the Geological Society of London, December, 1841, p. 576. Report on British Fossil Reptiles, Trans. British Association, 1841, p. 178.

Syn. CHELONE HARVICENSIS, *Woodward* (?).

The skull of a large *Chelone* (T. IX) from the Eocene clay near Harwich, in Professor Sedgwick's collection at Cambridge, resembles, in the pointed form of the muzzle, the *Chel. longiceps* of Sheppey; but differs in the greater convexity and breadth of the cranium (fig. 2); and the more abrupt declivity of its anterior contour (fig. 3), and from other *Chelones* by the broad expanse of the inferiorly-flattened *symphysis menti* (fig. 1).

The osseous roof of the temporal fossæ, and the share contributed to that roof by the postfrontals (T. IX, figs. 2 and 3, 12), distinguish the present, equally with the foregoing Chelonites, from the *Emys* (*Podoenemys*) *expansa*, and, *à fortiori*, from other genera and species of the fresh-water families (*Emydidæ* and *Trionicidæ*).

In the oblique position of the orbits (fig. 3, *o*), and the diminished breadth of the interorbital space (fig. 2), the present Chelonite, however, approaches nearer to *Trionyx* and *Emys* than do the previously-described species. But the sides of the face converge more rapidly towards the muzzle. Its most marked and characteristic difference from all existing *Chelones* is shown by the greater antero-posterior extent, breadth, and flatness of the under part of the symphysis of the lower jaw, whence the specific name here given to the species. The posterior border of the symphysis is defined by a regular semicircular curve, and the rami of the jaw have completely coalesced.

Since at present there is no means of identifying the well-marked species, of which the skull is here described, with the Chelonite figured in the frontispiece to Woodward's 'Synoptical Table of British Organic Remains,' and alluded to, without additional description or characters, as the *Chelonia Harvicensis*, in the additions to Mr. Gray's 'Synopsis Reptilium' (p. 78, 1831); and since the extensive deposit of Eocene clay along the coast of Essex, like that at the mouth of the Thames, contains the relics of more than one species of ancient British turtles,* I prefer indicating the one here established by a name having reference to its peculiarly distinguishing character, rather than to associate arbitrarily the skull, which gives the true specific distinction, with the ill-defined carapace to which the vague name of *Harvicensis* has been applied; more especially as the fossil carapace to which the present skull more probably belongs, from the circumstance under which it was discovered, also presents well-marked, and readily-recognisable specific characters.

This carapace (T. X) is also contained in the museum of Professor Sedgwick, and is understood to have formed part of the same individual turtle as the skull (T. IX) on which the species, *Chel. planimentum*, was founded.

In general form this carapace differs from that of the existing *Chelones*, in being less contracted and pointed posteriorly than in the *Chelone mydas* and *Chel caouanna*, and more contracted posteriorly than in the *Chel. imbricata*. In the proportion which the pleurapophyses (true ribs), bear to the superimposed costal plates, (*pl*4—8) it resembles *Chelone mydas*, and *Chelone caouanna*, more than it does the *Chel. imbricata*. But the pleurapophyses are more prominent and distinct from the costal plates throughout their entire length, than in the *Chel. mydas* or *Chel. caouanna*, and present an obtuse angular ridge towards the cavity of the abdomen.

The five posterior pairs of ribs of the carapace (*pl*4—*pl*8) are preserved, with part

* Sir C. Lyell alludes to the Chelonites of Harwich in his 'Elements of Geology:' "This formation is well seen in the neighbouring cliffs of Harwich, where the nodules contain many marine shells, and sometimes the bones of Turtles." (Vol. ii, p. 337.)

of the first three on the left side, and one of the coracoids (52) showing the rather sudden and considerable expansion of its sternal or mesial half.

The interval between the free extremities of most of the ribs, is about equal to twice and a half the breadth of each extremity; but the interval between the seventh (*pl7*) and eighth (*pl8*) rib, measured, like the others, at the terminal border of the costal plates, is equal to thrice the breadth of the free part of the seventh rib.

In this respect the *Chelone planimentum* resembles the *Chel. mydas* more than it does the *Chelone caouanna*, in which the interval between the free extremities of the seventh and eighth ribs is less than that between the sixth and seventh. The length of the costal plate of the fourth rib is twice that of the eighth rib, as in the *Chelone caouanna;* in *Chel. mydas* it is more than twice as long; in *Chel. imbricata* it is only one third longer. The marginal pieces in the *Chelone planimentum* seem to have been narrow or slender in proportion to their length.

The following admeasurements show that, in the large proportionate size of the head, the *Chelone planimentum* corresponds with the existing turtles:

	Inches.	Lines.
Length of the cranium	5	6
Depth of ditto	4	0
Breadth of ditto	5	0
Length of the carapace	15	6
Greatest breadth of ditto	13	0

Tab. IX and X satisfactorily illustrate the characteristic forms and proportions of the unique specimen in the Cambridge Museum; the carapace is figured of half the natural size.

Chelone crassicostata. *Owen.* Tab. XI and XII.

Testudo Plana. *König.* 'Icones Sectiles,' Pl. XVI, fig. 192?

That the extinct species of Eocene turtles attained larger dimensions than those given above, is proved by a fossil skull from the Harwich clay, in the collection of Professor Bell, which gives the following dimensions:

	Inches.	Lines.
Total length of the cranium	8	0
Its greatest breadth	6	0
The antero-posterior extent of the *symphysis menti*	3	0
The vertical diameter of the orbit	1	9
do. do. of the nostri	0	9

This skull differs from that of the *Chelone planimentum* in the minor depth of the maxillary bone below the orbit (compare T. IX, fig. 3, with T. XI, fig. 2, 21), in the more acute and attenuated muzzle; but especially in the minor breadth and the different configuration of the posterior margin of the *symphysis* of the lower jaw (compare T. IX, fig. 1, with T. XI, fig. 3). With regard to the comparative anatomy of the bones of the skull, and the pattern of the scutation of the upper surface of the cranium, I regret that the state of the specimen in Professor Bell's collection does not permit the deduction of other distinctive characters which such parts of the cranial organization so satisfactorily afford. A great proportion of the osseous parietes is wanting; but the cast in the hard matrix of the wide lateral cavities (12, 12), which were over-arched by the expanded postfrontal and parietal bones, indicates the prominence of the postfrontals at the upper and outer angle of the orbits. The orbits (*or*) appear to have been more ovate and less circular than in the *Chelone planimentum;* and the sides of the orbital part of the skull do not converge so rapidly towards the muzzle, but meet at a more acute angle.

That a second species of turtle, distinct from the *Chelone planimentum,* has left its remains in the Harwich clay, is very decisively demonstrated by the almost complete carapace in the British Museum, the inner surface of which is represented, on the scale of six inches to a foot, in T. XII. This carapace, both by its general contour, by the relative length of the costal plates to one another, and by their relative breadth to the adherent pleurapophyses beneath, more resembles the carapace of the *Chelone imbricata* than that of the other known existing species of turtle; and, as the peculiar characters of the *Chelone imbricata* are exaggerated, it differs in a proportional degree from the *Chelone planimentum.* These characters are seen in the great breadth of the prominent inferior part of the ribs, and of the free extremity of the rib (*pl*1—*pl*8), as compared with the total breadth of the costal plate. The intervals between the free extremities, where the expanded plate terminates, are not equal to the breadth of the proper ribs; in the *Chelone imbricata* they very slightly exceed the breadth of the free ends of the ribs. This character in the fossil, by which it is so markedly distinguished from the *Chelone planimentum,* and most other species, has suggested the name *Chelone crassicostata,* or thick-ribbed turtle, which is proposed for the present species. The last pair of ribs of the carapace (T. XII, *pl*8) are remarkably short and thick, and are curved backwards on each side the broad terminal neural plates which they almost touch. In this character the *Chel. crassicostata* resembles the *Chel. imbricata,* and differs from the *Chel. caouanna* (fig. 2, p. 3), and from *Chel. mydas.* The subequality of length of the costal plates is another character by which the *Chel. crassicostata* resembles the *Chel. imbricata,* and differs from the *Chel. mydas,* the *Chel. caouanna,* as well as from the *Chel. planimentum.*

In T. XII, as in the other figures, *ch* is the nuchal plate, *pl*1 the first rib of the carapace (the second free pleurapophysis or vertebral rib), *pl*2 to *pl*8 the remaining ribs of the carapace and costal plates; *s*9, *s*10, and *py* are the terminal neural plates and pygal plate, which, like the nuchal plate, are developed in the substance of the integument, without becoming attached to the subjacent spinous processes of the vertebræ. The debris of the neural arches of the intermediate eight vertebræ of the carapace are preserved in the interspaces of the beginnings of the ribs and costal plates in this beautiful Chelonite. It forms part of the Fossil Collection in the British Museum.

A carapace of a smaller individual of *Chelone crassicostata,* from the Harwich coast, with the character of the broad and inwardly-prominent ribs strongly marked, is likewise preserved in the choice collection of my esteemed friend Professor Bell. One of the hyosternal bones, inclosed in the same nodule of clay, testifies to the partial ossification of the plastron in this species by its coarsely-dentated border; and, at the same time, shows a specific peculiarity by the convexity of that surface which was turned towards the cavity of the thoracic-abdominal case. On the moiety of the nodule containing the carapace and exposing its under surface, the slender rudimental rib of the proper first dorsal vertebræ is preserved, in connexion with the first expanded rib of the carapace.

Besides the specimen of *Chelone crassicostata* from Harwich, figured in T. XII, there is a mutilated carapace of a young *Chelone,* from the same locality, in the British Museum. This specimen exhibits the inner side of the carapace, with the heads, and part of the expanded bodies, of four pairs of ribs, which indicate its specific agreement with the foregoing specimen, and demonstrate unequivocally its title to rank with the marine turtles. It is figured in Mr. Kœnig's '*Icones Sectiles*' (pl. xvi, fig. 192), under the name of *Testudo plana.*

A rare Chelonite from the hard Eocene clay apparently of Harwich, in the collection of my friend Frederick Dixon, Esq., F.G.S., of Worthing, shows the impressions from the under surface of the carapace, and also an instructive part of the under surface of the plastron itself. (T. XIII.) The proportions and degree of convexity of the under surface of the costal plates of the carapace (*pl, pl*) correspond with those parts in the *Chelone crassicostata.*

The remains of the plastron include a great portion of the left hyosternal (*hs*), left hyposternal (*ps*), and left xiphisternal (*xs*); the latter is articulated to the hyposternal by a notch, receiving a toothed process, and, reciprocally, near the upper part of a long oblique harmonia, between the outer border of the hinder angle of the hyposternal and the inner border of the upper half of the xiphisternal. The hyosternal is concave lengthwise, and is convex across on its under surface; the transverse linear impression, dividing the pectoral and abdominal scutes, crosses near its posterior border. The degree of concavity of the outer surface of this bone corresponds with the convexity of the upper and inner surface of the same bone in the specimen of the *Chelone crassicostata* from Harwich, in the Museum of Professor Bell; and it concurs with the characters of the costal plates in proving the present Chelonite to be of the same species. Impressions of the toothed mesial margin of the right hyosternal remain, and part of the toothed margin of the left hyposternal.

The right coracoid (52) is exposed by the removal of the right hyosternal; it differs in form from that preserved in the large specimen of *Chelone planimentum*, in Professor Sedgwick's Museum, in expanding less suddenly at its sternal end, as compared with the coracoid of the *Chelone mydas*, or with that of the *Chelone caouanna*, which is somewhat broader than in the *Chel. mydas;* the coracoid of the *Chel. crassicostata* agrees with that of the *Chel. planimentum* in the greater degree of its expansion. At the anterior fractured surface of Mr. Dixon's Chelonite, the long and slender columnar or rib-like scapula, is shown, extending from the under part of the head of the second costal rib downwards and outwards, for an extent of two inches, and then sending its acromial or clavicular prolongation at the usual open angle downwards and inwards to rest upon the episternal. The proportions of these parts of the scapular arch are quite those which characterise the genus *Chelone*, but they do not supply such marks of specific distinction as the coracoid element does.

Chelone declivis. *Owen.* Tab. XIV.

The extinct turtle represented by this specimen, and indicated by the above term, bears the same relation to the *Chelone convexa*, which the *Chelone longiceps** does to the *Chelone latiscutata*;† that is, it has the same general characters of the petrified parts of the carapace, but differs in the narrower proportions of the vertebral scutes (*v*1—*v*4), and the more open angle at which their two lateral borders meet; the vertebral angles of the costal scutes being correspondingly less acute.

The specimen is from the Eocene deposits of Bognor, Sussex, and is preserved in the collection of Frederick Dixon, Esq. It consists of the seven anterior neural plates, and the corresponding seven pairs of costal plates (T. XIV), those of the right side having been broken away from their attachments to the neural plates, and bent upon the rest of the carapace at an acute angle with some slight separation of the sutures of the costal plates (fig. 2).

The neural plates correspond in general form with those of the *Chelone convexa*, the hind ones being rather broader; the first (*s*1) is crossed at its middle part by the impression dividing the first (*v*1) from the second (*v*2) vertebral scute; the second neural plate (*s*2) is an oblong four-sided one, with both ends of equal breadth. The third neural plate, *s*3, resumes the hexagonal figure with the broadest end, and two shortest sides at the fore part; and is crossed in its lower half by the impression dividing the second, *v*2, from the third vertebral scute, *v*3. The fifth neural plate (*s*5) is crossed by the next transverse impression nearer its lower border. The sixth and seventh neural plates retain the same form and proportions as in the *Chelone convexa*, except a somewhat

* Proceedings of the Geological Society of London, December 1, 1841, p. 572.

† Ibid., p. 574.

greater breadth, and have not their antero-lateral borders increased in length, as in the *Chelone longiceps.*

The declination of the ribs from the neural plates, gives a greater degree of steepness to the sides of the carapace than in the *Chelone convexa*, and the impressions of the scutes have equal depth and breadth. The chief difference indicative of specific distinctions, lies in the form of those impressions; and the question is, whether, in the progress of growth which makes the longitudinal extent of two of the vertebral scutes in one specimen nearly equal to three, in another, so great a change could be effected in their shape as is shown in the specimen of *Chelone convexa;* in which it will be seen that the second vertebral scute (T. VII, *v*2), though more than one third shorter than in *Chel. declivis* (T. XIV, *v*2), is of the same breadth as that in the larger specimen, and that the rest differ in the same remarkable degree.

Chelone trigoniceps. *Owen.*

More than one of the old tertiary turtles (*Chelone*) are remarkable for the longitudinal extent or depth of the symphysis of the lower jaw.

The turtles from the Eocene clay at Harwich have this character so strongly developed and the under surface of the symphysis so flattened, especially in one of the species, as to have suggested the "nomen triviale" *planimentum* for it. The *Chelone longiceps,* if we may judge by the length of the upper jaw and bony palate, must have had a corresponding extent of the symphysis of the under jaw; and we may infer the same peculiarity from the straight alveolar borders of the maxillaries and their acute convergence towards the premaxillary bones in an allied species, *Chelone trigoniceps,* which I have described and figured in the Appendix to Mr. Dixon's work on the 'Fossils of Sussex,' from a specimen which is in the collection of G. A. Coombe, Esq., and which was obtained from the Eocene clay at Bracklesham.

Amongst the Chelonites which Mr. Dixon has obtained from the same formation and locality, are portions of the fore part of the lower jaw of four individuals of the genus *Chelone,* all exhibiting the characters of the pointed form and great depth of the symphysis.

One of these specimens agrees so closely in size and shape with the fore part of the upper jaw of the *Chelone trigoniceps*—fits, in fact, so exactly within the alveolar border, and so closely resembles that specimen in texture and colour, that, coming from the same formation and locality, and being obtained by the same collectors, I strongly suspect it to belong to the same species of *Chelone,* if not to the same individual.

The known recent *Chelones* differ among themselves in the shape and extent of the bony symphysis of the lower jaw. Both the *Chelone imbricata,* and *Chelone caouanna* have this part deeper and more pointed than the *Chel. mydas,* but neither species has the symphysis so depressed or so slightly eonvex below as it is in the Braeklesham *Chelones.*

These also differ amongst themselves in this respeet. The symphysis whieh I have referred to the *Chelone trigoniceps,* is the broadest and flattest ; at its baek part it shows a deep and broad genio-hyoid groove ; this is redueed to a transversely oblong foramen in *Chelone mydas.*

The seeond speeies from Braeklesham, is indieated by the maxillary symphysis, the sides of whieh meet at a more aeute angle, and it is narrower in proportion to its length, is more eonvex below, and more eoneave above, with the alveolar borders a little more raised, and the middle line less raised than in *Chelone trigoniceps.* In this respeet it is intermediate between the *Chelone imbricata,* where the upper surfaee of the symphysis is more eoneave, and the *Chelone caouanna,* where it is flatter than in the *Chelone trigoniceps.* The fossil symphysis under notiee, has also a smooth, transverse, genio-hyoid groove at its baek part. It aeeords so elosely in form with the end of the upper jaw of the *Chelone longiceps,* from Sheppey, that I refer it provisionally to that speeies.

Two other speeimens of the symphysis of the lower jaw, of rather larger size, appear to belong to the same speeies as that referred to the *Chel. longiceps,* by the eharaeters of the eoneavity of the upper surfaee, the eonvexity of the lower surfaee, and the degree of eonvergenee of the sides or borders of the symphysis. The larger of the two shows the genio-hyoid groove, and the nearly vertieal outer side of the jaw, opposite the baek part of the symphysis, and this shows no impression of the smooth fossa reeeiving the insertion of the biting museles, whereas, in the *Chelone trigoniceps,* fig. 11, that fossa extends to the same transverse line or parallel with the baek part of the symphysis.

The very rare and interesting Chelonite in Mr. Coombe's museum, was the first portion of the eranium of a reptile of this order that I had seen from the Eoeene deposits at Braeklesham. It ineludes the bones forming the roof of the mouth, with portions of the bony nostrils and orbits, and the tympanie pedieles.

The extremity of the upper jaw is broken off, but the straight eonverging alveolar borders elearly indieate the muzzle to have been pointed, as in the *Chelone longiceps* of Sheppey ; and the muzzle being shorter, the form of the skull has more nearly approaehed that of a right-angled triangle. The whole eranium is broader and shorter, and the tympanie pedieles wider apart. The middle line of the palate developes a somewhat stronger ridge ; the orbits were relatively larger and advaneed near to the muzzle : the malar bones are more protuberant behind the orbits, and their external surfaee inelines inwards as it deseends from behind and below the orbit, to form the lower border of the zygoma, whieh it does not do in the *Chelone longiceps.*

The upper surfaee of the fossil shows the palatines rising to form the vomer at the middle line, and the two small subeireular vaeuities (oeeupied by membrane in the recent skull) between the palatines, prefrontals, and maxillaries; the anterior border of the temporal fossa, formed by the malar and pterygoid, is entire on one side, and shows that that vacuity was as broad as it is long. The olfactory excavations in the maxillaries are deep. The articular surface of the tympanitic pedicles closely accords with those of recent *Chelones*. The very regular triangular form of the skull indicated by this fragment, has induced me to propose the name of *Chelone trigoniceps* for the species.

Chelone cuneiceps. *Owen.* Tab. XV.

One of the most complete and instructive crania of the fossil turtles of our Eocene deposits is the subject of T. XV, the opportunity of describing and figuring which has been kindly afforded me by J. Toulmin Smith, Esq., F.G.S., of whose cabinet it forms part, and by whose skilful manipulation its variously configurated exterior has been disencumbered of the hard adherent clay.

From the *Chelone breviceps* this specimen differs by its more prolonged and pointed muzzle; by the more sudden and sloping declivity of the prefrontal part of the cranium (fig. 1, 14); by the minor degree of rugosity of the surface of the bones; and by the different disposition of the superincumbent horny scutella, which is indicated by their impressions. In the general arrangement of these impressions it accords better with the cranium of the *Chelone longiceps;* but differs in the greater breadth of the skull as compared with its length; in the minor extent of the bony palate (fig. 3, 20, 21), the more advanced position of the posterior nostrils, and the greater length of the pterygoids (24). From the *Chelone convexa* it differs, in the greater relative breadth and flatness of the frontal bones, and of the whole interorbital platform (fig. 2, 11), in the downward slope of that part of the cranial profile, and in the more prominent convexities of the palatal processes of the maxillaries. From the *Chelone planimentum* it differs also, by the broader prefrontal part of the interorbital space, as compared with the transverse diameter of the back part of the skull; by the minor degree in which the frontal enters into the formation of the upper rim of the orbits; by the minor depth of the suborbital part of the maxillary and malar bones, and by a very different arrangement of the supracranial horny scutella.

The basi-occipital (T. XV, figs. 3 and 4) is remarkable for the strong development of the tubercles for the insertion of the strong "recti capitis antici," and for the depth of the median groove between them; the semicircular fossa in front of these processes is bounded by a well-developed basi-sphenoidal ridge (5), the curve of which is deeper than in *Chel. longiceps,* but shallower than in *Chel. breviceps.* In the *Chel. caouanna,* in which the basi-occipital tuberosities are better developed than in the *Chel. imbricata* or *Chel. mydas,* they are bounded anteriorly by an angular or chevron-shaped ridge of the basi-sphenoid. The exoccipitals (2) form the usual share of the trilobate occipital condyle characteristic of the *Chelonia*. The paroccipitals (4) project backwards to a little beyond the posterior plane of the condyle, indicating an affinity to the *Trionycidæ*. The inferior surface of the part of the tympanic to which they unite is concave. The parietals (fig. 2, 7) form together a large semielliptic, almost flattened, platform, relatively broader than in *Chel. mydas*, not convex, as in *Chel. caouanna;* not indented by the mastoids, as in the *Chel. longiceps*, and not forming an angle between the frontals and postfrontals, as in the *Chel. breviceps*. The frontals (11) together form a pentagon, with the longest margin joining the parietals, the next in length converging to a point between the prefrontals, and the shortest borders joining the postfrontals. The postfrontals (12) and prefrontals (14) almost meet above the orbits, and exclude the frontals from entering into the formation of its superior border. The *Chel. mydas* comes nearest to the *Chel. cuneiceps* in this particular; whilst in the *Chel. imbricata* the frontals enter as largely into the formation of the upper border of the orbit as they do in the *Chel. breviceps*, *Chel. longiceps*, and *Chel. convexa*.

The precise form of the termination of the prefrontonasals, the maxillaries, and premaxillaries cannot be determined in the present specimen; fortunately, the fracture of the anterior extremity of the skull has not extended to that of the bony palate. If this be bounded by a transverse line behind, drawn across the anterior border of the temporal fossæ, the space included forms a right-angled triangle, and includes the whole of the posterior nostrils. In the *Chel. longiceps* the similarly defined space has the base shorter than the converging sides, and the posterior nasal aperture is behind the transverse line. The bony palate, also, of *Chel. cuneiceps*, instead of being pretty uniformly concave and even, as in *Chel. longiceps* and *Chel. caouanna*, is raised on each side between the middle line and the marginal alveolar plate into two convexities, as in *Chel. mydas* and *Chel. imbricata;* but the most prominent part of the palatal convexities (figs. 3 and 4, 21) is obtuse in *Chel. cuneiceps*, not sharp or angular, as in *Chel. mydas* and *Chel. imbricata*.

The palatal part of the vomer (13) forms the median longitudinal groove dividing the convexities, which are formed by the palatal processes of the maxillary bones. The small part of the alveolar border of the maxillary which is entire terminates in a sharp edge, extending about four and a half lines below the level of the palate.

The ridge of the palatines, which forms the anterior boundary of the posterior nostril, is not produced or bent below the level of the bony palate, as in *Chel. caouanna*, and as it is, although in a minor degree, in *Chel. mydas;* and there is not that concavity between it and the oblique palatal tuberosity which exists in the *Chel. mydas* and *Chel. imbricata*.

The pterygoids are more deeply (semicircularly) emarginate laterally than in any of the existing species of *Chelones*, and they are shorter in proportion to their breadth; they bound internally the lower apertures of the temporal fossæ, which are broader than they are long; in all the existing *Chelones* the opposite proportions prevail, and in *Chel. imbricata* especially the homologous apertures are twice as long as they are broad. The pterygoids, in the *Chel. cuneiceps*, develope a sharp ridge along their median suture; and short but well-defined processes at their anterior and outer angles. The channel or concavity upon the under part of the diverging portion of the pterygoid conducts obliquely into the temporal fossæ in the *Chel. mydas;* in *Chel. cuneiceps* it leads directly forwards upon the under surface of the anterior part of the pterygoids exclusively, as in the *Chel. imbricata* and *Chel. caouanna.*

In the *Chel. mydas* the malar approaches the mastoid very closely, and sometimes touches it by the posterior angle, thus separating the squamosal from the postfrontal; the extent of the union between the squamosal and postfrontal is also shorter in the *Chel. caouanna* than in the *Chel. imbricata.* In the extent of that union (between 12 and 27) the *Chel. cuneiceps* resembles the *Chel. imbricata,* as do likewise the *Chel. breviceps* and *Chel. longiceps.* But the *Chel. cuneiceps* differs from all the recent species in the form of the squamosal (27), which is bent upon itself, forming a slightly curved linear eminence, where the lower and smoother part of the bone is bent, and, as it were, pressed inwards towards the tympanic (28), against which it abuts. This modification is natural, not the effect of accidental pressure upon the fossil. The lower border of the malar (26), which intervenes between the maxillary and squamosal, is sharp but convex, as in *Chel. caouanna,* not concave as in *Chel. mydas,* nor nearly straight, as in *Chel. imbricata.* But the concave curve of the inferior margin of the squamosal (27) most resembles that in *Chel. imbricata.* The antero-posterior extent of the mastoid (8) is less proportionally than in any of the recent *Chelones,* and it forms a smaller share of the upper border of the large meatus auditorius. The articular part of the tympanic descends below the squamosal further than in the recent turtles; and its articular surface is more convex at its outer half, and more concave at its inner half; *Chel. imbricata* makes the nearest approach to the fossil in this respect. In the *Chel. mydas* and *Chel. caouanna* the articular surface is nearly flat.

As the supracranial scutella have left unusually deep and well-marked impressions on this fossil skull, I have reserved their description, and the comparison of their different forms and proportions in the several fossil species, to this place.

Three scutella occupy the median line of the upper surface of the cranium in the present species of *Chelone,* which, from the absence of any impression along the frontal and sagittal sutures, appear to have been single and symmetrical. The anterior and smallest answers to the "frontal" scute (*fr*); the next in size and position to the "sincipital" scute (*sy*); the hindmost and largest answers to the "occipital" scute (*oc*), which is usually divided, and forms a pair in existing *Chelones.*

The frontal scute is long, narrow, hexagonal, broadest across the antero-lateral angles, from which the impressions extend outwards to the supraorbital margin, which divide the "fronto-nasal" scute from the "supraorbital" scute (*ob*).

The sincipital scute is bounded on each side by a sigmoid curve, and both before and behind by an entering angle; it is broadest behind, and from the middle of the lateral border proceeds the transverse impression towards the back part of the orbit, which divides the "supraorbital" scute (*ob*) from the "parietal" scute (*pa*). The occipital scute is bounded laterally by straight lines, which slightly diverge as they extend backwards: there is no trace of an interoccipital scute. The parietal (*pa*) scute is the largest; impressions of five of its borders are preserved in the present fossil: the two exterior ones meet at an obtuse angle, a little above the middle of the *meatus auditorius externus;* the antero-external border uniting with the postorbital scute (*po*); the postero-external border with the external occipital scute (*co*).

In the *Chelone breviceps* (T. I) the frontal scute is relatively larger than in the *Chelone cuneiceps,* and is nearly as broad as long. The sincipital scute is bounded laterally by two straight lines meeting at a very open angle, from which the transverse impression extends outwards between the supraorbital and parietal scutes. The straight lines bounding the sides of the occipital scute diverge from each other as they extend backwards more than they do in the *Chelone cuneiceps.*

In the *Chelone longiceps* (T. III) a still more different pattern of the supracranial scutation is presented. The occipital scutes (*oc*) are separated by an intervening interoccipital scute (*io*). The lateral borders of the sincipital scute are each bounded by three lines and two angles; the antero-lateral and postero-lateral angles being curved with the concavity outwards; and the transverse impression dividing the supraorbital scute (*ob*) from the parietal scute (*pa*), proceeds from the middle of the intervening straight border of the parietal. The frontal scute (*fr*) is long and narrow, broadest behind, with its lateral borders gradually converging to a point anteriorly; the impression dividing the supraorbital (*ob*) from the frontonasal scute (*fn*) proceeds from the middle of that lateral border. Neither the division between the frontal and sincipital, nor that between the sincipital and interoccipital scutes are well marked.

The *Chelone convexa* (T. VI, fig. 4), like the *Chelone longiceps,* has an interoccipital scute (*io*), and the sincipital scute (*sy*) has its sides bounded by three lines, of which the posterior one is curved with its concavity towards the occipital scute (*oc*), and so directed as to appear to form part of the posterior rather than the lateral border; the other two lines completing the lateral border and converging forwards, are divided or defined by a slight angle, from which the transverse impression proceeds outwards, which divides the supraorbital (*ob*) from the parietal (*pa*) scutes. The frontal scute (*fr*) is a small hexagon, relatively wider than in *Chel. longiceps* or *Chel. cuneiceps.* The impression dividing the supraorbital (*ob*) from the frontonasal (*fn*) scutes proceeds from the angle between the lateral and anterior sides of the frontal scute.

The *Chelone planimentum* (T. IX) is peculiar, and differs from all the foregoing species by the forward extension of the occipital scutes which join the supraorbital scutes, and thus divide the sincipital scute (*sy*) from the parietal scute (*pa*); the sincipital scute is correspondingly encroached upon, as it were, and narrowed, its broadest part being nearer the anterior end, at the angle between its two straight lateral borders, from which angle the impression extends outwards that divides the occipital from the supra-orbital scute. The frontal scute (*fr*) is small and narrow, and the large supraorbital scutes meet in front of it at the middle line. They appear to be divided from the orbits by the encroachment of palpebral scutes (*pl*) upon the supraorbitary border. There appears to have been an interoccipital scute in the *Chel. planimentum*, as in the *Chel. longiceps* and *Chel. convexa*.

Amongst existing *Chelones* the interoccipital scute is constant only in the *Chel. caouanna*—the loggerhead of Catesby and Brown; but the sincipital scute in this species is vastly larger in proportion than in any of the fossils above described; and it is further distinguished by the peculiar division of the supraorbital and parietal scutes.

In the hawks-bill turtle (*Chel. imbricata*), the supracranial scutes leave as well-marked indentations upon the bones of the cranium as are seen in most of the fossil turtles, but the supraorbital scute is proportionably larger than in any of these, and the proportions and forms of all the other scutes are different. There are, also, two nasal scutes divided by a transverse groove from the frontonasals, which groove I have not yet met with in the corresponding part of any of the fossil Chelonian crania.

The skull of the *Chelone cuneiceps*, here described, is from the London clay of Sheppy.

Chelone subcarinata. *Bell.* Tab. VIII *A.*

The resemblance of this species to *Chelone subcristata* (p. 24, T. VIII) is so considerable, that it has not been without some hesitation that I have ventured to describe it as distinct. There are, however, certain characters by which it may be distinguished, and those of sufficient importance to be considered as specific. On comparing it with recent species, and even with most of the fossil ones from the same locality, there is a remarkable evenness in the arch of the carapace, which, with the exception of a slight carina on some of the posterior neural plates, to be hereafter mentioned, forms nearly a perfect arc of a circle, from the extremity of the costal plate of the one side to that of the other, without that flattening of the side which is seen in most other species.

The nuchal plate (T. VIII*A*, fig. 1, *ch*) has the posterior margin arched, and there is a short median process which goes to join the first neural plate (*s*1), in which respect it agrees with *Chel. longiceps* and with *Chel. subcristata.* This process is emarginate, to receive a slight triangular projection of the anterior margin of that plate. The first neural plate (*s*1) forms a parallelogram, the sides not being interrupted by any costal suture; the posterior suture of the first costal plate (*pl*1) extending to the second neural plate (*s*2). In this circumstance it differs from *Chel. subcristata, longiceps,* and *convexa,* and agrees with *Chel. breviceps.* This, however, may possibly be a variable character here, as it is in *Chel. longiceps;* in one specimen of which, now before us, Professor Owen found that the articulation in question was to the anterior part of the second, instead of the posterior part of the first, neural plate; in other words, that the first neural plate was the isolated one instead of the second. The remaining neural plates are hexagonal, becoming almost regularly shorter to the eighth; the lateral angles meeting the costal sutures being nearly at the same distance from the anterior margin in each, and in no one at all approaching a regular equilateral hexagon, as in many of the neural plates in *Chel. breviceps.* The first three, and the anterior half of the fourth neural plates are flat; but on the posterior half of the fourth commences a low carina, which becomes highest on the posterior half of the sixth (*s*6), and anterior half of the seventh (*s*7). It thus differs from *Chel. subcristata,* in which there is a distinct, short, sharp, longitudinal crest (*s*1) on the fifth and seventh neural plates, " and a similar crest is developed on the contiguous ends of the second and third neural plates." The ninth and tenth neural plates are wanting in the only specimen I have seen of the *Chel. subcarinata.*

The first costal plate is flat (*pl*1), but the remaining ones, to the seventh inclusive, are slightly hollowed along the middle, being raised towards the anterior and posterior margins, where they are articulated to the contiguous ones. The whole surface of the bones of the carapace is less smooth than in most other fossil species, and conspicuously less so than in *Chel. subcristata.*

In describing the forms of the vertebral scutes, (*v*1—*v*4), and of the costal ones as depending upon them, it is necessary, in order to arrive at any satisfactory comparison between these parts in different species, to bear in mind that a great change takes place in their outline during the growth of the animal; and that a vertebral scute, which, in a younger individual, has the middle of its outer margin exceedingly extended, so as to form a very acute angle, where the lateral margin of the costal scute joins it, and thus rendering it twice as broad as it is long, may in more advanced age have that angle very open, and having increased greatly in length, and scarcely at all in breadth from angle to angle, the length becomes greater than the breadth. Allowing, however, for this fact, there are doubtless considerable variations in this respect according to the different species, which are permanent and well marked. The first vertebral scute (*v*1) in the present species is quadrilateral, broader anteriorly; the second and third (*v*2, *v*3) hexagonal, with the outer margins slightly waved, somewhat broader in the middle at the angles than at the anterior and posterior margins, the comparative breadth at that part being rather greater than in the corresponding scutes of *Chel. subcristata,* and much less so than in *Chel. convexa, Chel. breviceps,* or *Chel. longiceps.* The fourth vertebral scute (*v*4) is also hexagonal, but the portion posterior to the lateral angles is narrowed and produced backwards. The last of the series is fan-shaped. The outline of the costal scutes follows of course that of the vertebral ones.

The plastron, in the specimen from which this description is taken (Pl. VIII, A, fig. 2), is more perfect than in that of almost any other fossil Chelonian I have seen. It agrees in its general form with that of *Chel. subcristata,* but is less extensive, as regards its bony surface, than in *Chel. longiceps* or even than in *Chel. breviceps.* The entosternal bone (*s*) is somewhat wedge-shaped, with the anterior margin triangular, and a short winged process on each side of the anterior third of the bone extending outwards and backwards. The posterior extremity of the bone, and the winged processes are dentate. The episternals (*es*) are aliform, tending backwards and outwards, and inclosing between them the head of the entosternal (*s*), and the anterior processes of the hyosternal bones (*hs*). The latter have the anterior processes extending forwards on each side of the entosternal, approximating at their extremity the aliform processes of that bone. The median or internal processes nearly meet on the median line, and the dentations are deep but slender; each hyposternal (*ps*) unites similarly with its fellow, and the posterior process extends backwards, in a long, narrow, triangular piece, uniting with the xiphisternal (*xs*), which latter forms a very elongated rhomb, the breadth of which is scarcely one fourth of its length, which in the present specimen is no less than two inches six lines. This form, with the elongation and narrowness of the posterior process of the hyposternal, gives to the hinder portion of the plastron in this species a narrower and more elongated outline than we find in almost any other; an approach to which is, however, indicated in the imperfect specimen of *Chel. subcristata* figured in Plate VIII.

The external notch, between the external process of the hyosternal and hyposternal, is deep and rounded. The central interspace is nearly quadrate, and about half as long again as it is broad.

	Inches.	Lines.
Length of the carapace as far as it is preserved	9	5
Breadth of ditto from the extremity of the third costal plate on one side to that on the other	7	4
Ditto, following the convexity of the carapace	9	3
Length of plastron from the anterior margin of the episternal to the extremity of the xiphisternal	8	4
Breadth of ditto across the hyosternals	7	0

The only specimen of this species which I have seen is from Sheppy, and is in the fine collection of J. S. Bowerbank, Esq., F.R.S.

T. B.

SUPPLEMENTAL REMARKS

ON THE

TURTLES FROM THE LONDON CLAY AT HARWICH.

In the progress of the works now carried on in a part of the Harwich cliffs, with a view to the acquisition of the remains of the animal tissues and bone-earth which form the nodules that are ground up and used as manure, many remains of the Chelonian reptiles which formerly frequented the seas from which those Eocene tertiary strata have been deposited have been discovered. Mr. Colchester, of Little Oakley, Essex, who carries on large works of this kind for the "Fossil Guano," as it is termed, has transmitted to me a number of the nodules in question. The most intelligible and instructive of these I have marked from 1 to 10 consecutively, and shall notice them here in the same order.

No. 1. *Chelone planimentum.* This is the half of an oval nodule of petrified clay, 20 inches in length, by 17 inches in breadth, exposing an irregular group of disarticulated bones of the carapace and other parts of the skeleton. The species is determined by a fragment of one of the costal plates with the connate rib. The plate measures $2\frac{1}{2}$ inches in breadth, the rib 8 lines, and forms the usual partial prominence from the even surface of the under part of the costal plate. Almost the whole of the very broad but short nuchal plate is recognisable: it measures 6 inches in transverse diameter, and only $1\frac{1}{2}$ inch in antero-posterior diameter. Part of the hyosternal bones, and the impression of the humerus are recognisable.

No. 2 is the half of a nodule, 20 inches in length and 17 inches in breadth, exposing part of the plastron, and some other bones of the skeleton of the *Chel. planimentum.* It shows well the natural form of the under and outer part of the hyposternal bone, which is much more deeply excavated than in the *Chel. crassicostata;* the lower portion of the bone is narrower in proportion to its length, and the xiphisternals are also in proportion longer and narrower than in that species.

No. 3. *Chelone planimentum.* The half of an oval nodule, 17 inches in length and 13 inches in breadth. The fractured side exposing a cast of the inner surface of the carapace, which measures in length from the nuchal to the tenth neural plate inclusive $13\frac{1}{2}$ inches; and in breadth, across the third pair of costal plates from one end of the projecting rib to that of the opposite side, 11 inches. The anterior contour of the carapace is well shown in this nodule, the marginal plates which join the nuchal plate being preserved. The free extremity of the rib attached to the third costal plate projects 1 inch 9 lines from that plate, and measures 7 lines in breadth, where it becomes free; the breadth of the plate being nearly 2 inches. The transverse curve of the carapace is shown by this specimen to be much less than in the *Chel. crassicostata*.

No. 4. *Chel. planimentum.* The nodule shows partly a cast of the outer surface of the carapace, with part of the carapace itself. The outer angles of the third and fourth vertebral scutes are here seen with the inner angle of the third costal scute. The outer angles of the vertebral scutes are more prominent than in *Chel. declivis*, *Chel. subcristata*, *Chel. subcarinata*, *Chel. convexa*, or *Chel. longiceps*; they resemble most those in *Chel. breviceps*. The breadth of the third costal scute is 4 inches. The characteristic angular ridge, formed by the narrow connate rib, where it projects from the lower surface of the costal plate, is well shown in this specimen.

No. 5. A nodule showing a cast of the under surface of the carapace seen from above, apparently of the *Chel. planimentum*.

No. 6. A nodule, 10 inches long by 9 inches broad, showing a still more imperfect cast of the under surface of the carapace, of apparently a younger specimen of the *Chel. planimentum*.

No. 7. A fragment of a nodule showing the outer dentated extremity of the left hyosternal of the *Chel. planimentum*.

No. 8. A portion of a nodule, with part of the carapace of the *Chel. planimentum*, showing the second to the seventh neural plates inclusive, and portions of the second to the seventh costal plates of the right side, with more or less of their bony substance broken away, exposing their coarse fibrous character, the fibres diverging on each side from the subjacent rib, as they extend obliquely towards the periphery of the carapace. The third neural plate is 2 inches 3 lines in length and 1 inch in breadth; it is crossed at its middle part by a moderately broad and deep channel, indicating the junction of the second with the third vertebral scute. The third neural plate is hexagonal; the two shortest sides being formed by the truncation of the contiguous angles of the second costal plates bending down a little to articulate with them. The fourth neural plate is 2 inches 6 lines in length, and 1 inch 4 lines across the broadest part. The anterior surface is concave, the posterior convex; the two longest sides converge towards the posterior surface, and are straight. The fifth and sixth neural plates progressively decrease in length, without a proportionate decrease in breadth. The breadth of the fourth costal plate is 2 inches 3 lines at its peripheral extremity: its length is 6 inches; the rib projects 2 inches beyond it. The upper surface of the neural and costal plates is so minutely fibrous or striated as to seem at first sight almost smooth. The upper surface of the costal plate seems naturally to be slightly concave in the direction of the axis of the carapace, but not so much as in *Chel. crassicostata,* and the rib is much bent lengthwise.

No. 9. *Chelone crassicostata* (T. XIII*A*). This instructive specimen is contained in a subspherical nodule, 13 inches long by 12 inches broad, exposing a large proportion of the outer surface of the carapace, with more than one half of the circle formed by the marginal plates (*m7—py*). The carapace has been fractured, and the ribs of the left side dislocated and pressed down below those of the right. The third (*pl*3) to the eighth (*pl*8) costal plates inclusive are present on the left side; the fifth to the eighth on the right side, and the neural plates from the fourth to the pygal plate (*py*) inclusive. The fourth, fifth, and sixth neural plates are hexagonal, with the anterolateral sides shortest, and chiefly remarkable for their great breadth in proportion to their length. The seventh and eighth are small, and more regularly hexagonal. The ninth is a broad subcrescentic plate, with the broad concave side backwards, and the space between this and the pygal plate is filled up by an equally broad but pentagonal neural plate. The length of the ninth and tenth neural plates, with the pygal plate inclusive, is 2 inches 9 lines. The pygal plate is subquadrangular and broadest behind, where it is slightly emarginate. The length of the fourth to the eighth neural plate inclusive is 3 inches 8 lines. The upper surface of the bones of the carapace is almost smooth. That of the costal plates is chiefly remarkable for its concavity transversely, or in the direction of the axis of the carapace, which is to a greater degree than in the *Chel. subcristata* or *Chel. longiceps;* the lines of the sutural union of these plates with each other forming so many ridges across the sides of the carapace. The degree of curvature or convexity in the direction of the length of the costal plate is much greater than in the *Chel. planimentum.* The length of the third costal plate is $3\frac{1}{2}$ inches, its breadth at the outer extremity, 1 inch 4 lines; the breadth of the rib where it projects beyond it is 9 lines. The margin of the plate attached to that rib is 1 inch 4 lines in length, and 8 inches in breadth. The margin of the plates gradually increases in breadth towards the posterior part of the carapace, the one joining the pygal plate being 1 inch 2 lines in breadth. The general form of the carapace of the *Chel. crassicostata* is shown by the present specimen to have been that of a full oval, with a gently festooned border, not pointed behind.

No. 10. *Chelone crassicostata* (T. XIII*B*.) A still more remarkable example of this species was kindly transmitted to me by the Rev. S. N. Bull, M.A., of Harwich, of which a figure is given in T. XIII*B*. When it first came into my hands it was an unpromising semioval nodule, 10 inches in length by 7 inches in breadth, presenting on its convex surface portions of the posterior neural and costal plates, with their external surface entire; but no trace of plastron on the flattened side. The degree of convexity formed by the costal plates equalled that of the most dome-shaped tortoise. The flatter surface of the nodule was slightly convex, which I thought might arise from a layer of petrified clay adhering to the plastron. A portion of the cranium was indicated at the produced angle of the nodule. To ascertain whether this remarkable degree of convexity of the carapace, both lengthwise and transversely, was natural, I had the matrix carefully removed, with the permission of the owner of the specimen, and the same was done on the opposite side, with a view to expose the plastron. Instead of finding a plane plastron where it was expected, in its natural horizontal position, it was found to have been crushed inwards, as represented in fig. 2, by the pressure of a hard petrified mass as big as a paving-stone, which had been forced in upon this part of the body of the turtle whilst in a decomposing state; and when finally lodged in the clay, the carapace and plastron, as they became dislocated, had become more or less moulded upon it; and thus was produced the convexity which originally attracted my attention. In the breadth of the connate rib, as compared with that of the costal plate, in the extent of the free extremity of the rib, in the degree of concavity of the upper surface of the costal plate and the curvature lengthwise, the distinctive characters of the *Chel. crassicostata* are well shown. The same characters are likewise presented by the parts of the plastron, as in the breadth of the xiphisternals (*xs*), the curvature of the hyosternal (*hs*), and the form of the coracoid. The two scapulæ, with the connate acromial clavicles, are preserved, with the head of one of the humeri. A part of the basis cranii, showing the broad diverging pterygoid, with their characteristically-channeled inferior surface, is shown in fig. 2; these grooves are not so deep, however, as in *Chel. longiceps*, but are more like those in *Chel. cuneiceps*.

I beg to record my obligations to Mr. Bowerbank for the suggestion, and to Mr. Bull for his ready response to it, to which I owe the opportunity of examining this specimen of the thick-ribbed turtle of the Harwich cliffs.

A fossil mandible of a Chelonian, in the collection of the Marchioness of Hastings (figured, of the natural size, in T. XIX*D*, figs. 1 and 2), most resembles that part in the genus *Chelone* by its general form and proportions, and especially by the configuration of the biting and grinding surface of the jaw (fig. 2). The symphysis is confluent; convex in both directions below; longer than in the *Chel. mydas* and the *Chel. breviceps* of Sheppy (T. I, fig. 3, 32); but not so long as in the turtles from Harwich (T. IX, fig. 1, and T. XI, fig. 3) and Bracklesham, or as in the *Chelone longiceps* of Sheppy. The rami diverge more from each other than in the lower jaw of the *Chel. convexa* (T. VII, fig. 3) of Sheppy.

A ridge, commencing at the fore part of the upper surface of the symphysis, passes backwards, and divides the two ridges, diverging and circumscribing with the outer sharp margins of the jaw an elliptical concave space on each side; the space between the diverging ridges is raised and rough: this part has been fractured. In the *Trionyx*, of which genus so many fine examples have been met with at Hordwell, the upper part of the symphysis presents an uniform concavity; and this part of the jaw is narrower and more produced. I have not yet seen the mandible of any Emydian or land-tortoise resembling the present fossil so closely as some of the marine species above cited. A large species of *Emys* has, however, left its remains in the same deposits at Hordwell as the *Trionyces* next to be described.

A retrospect of the facts above detailed, relative to the fossil Chelonians of the genus *Chelone,* or marine family of the order, leads to conclusions of much greater interest than the previous opinions respecting the Chelonites of the London clay could have suggested. Whilst these fossils were supposed to have belonged to a fresh-water genus, the difference between the present fauna and that of the Eocene period, in reference to the Chelonian order, was not very great; since the *Emys* or *Cistuda Europæa* still abounds on the continent after which it is named, and lives long in our own island in suitable localities. But the case assumes a very different aspect when we come to the conviction that the majority of the Eocene Chelonites belong to the true marine genus *Chelone;* and that the number of species of these extinct turtles already obtained from so limited a space as the Isle of Sheppy, exceeds that of the species of *Chelone* now known to exist throughout the globe.

Notwithstanding the assiduous search of naturalists, and the attractions to the commercial voyager which the shell and the flesh of the turtles offer, all the tropical seas of the world have hitherto yielded no more than five* well-defined species of *Chelone;* and of these only two, as the *Chel. mydas* and *Chel. caouanna,* are known to frequent the same locality.

It is obvious, therefore, that the ancient ocean of the Eocene epoch was much less sparingly inhabited by turtles; and that these presented a greater variety of specific modifications than are known in the seas of the warmer latitudes of the present day.

The indications which the English eocene turtles, in conjunction with other organic remains from the same formation, afford of the warmer climate of the latitude in which they lived, as compared with that which prevails there in the present day, accord with those which all the organic remains of the oldest tertiary deposits have hitherto yielded in reference to this interesting point.

That abundance of food must have been produced under such influences cannot, of course, be doubted; and we may infer that, to some of the extinct species, which, like the *Chel. longiceps* and *Chel. planimentum,* exhibit either a form of head well adapted for penetrating the soil, or with modifications that indicate an affinity to the *Trionyces,* was assigned the task of checking the undue increase of the now extinct crocodiles and gavials of the same epoch and locality, by devouring their eggs or their young; becoming probably, in return, themselves an occasional prey to the older individuals of the same carnivorous Saurians.

* Mr. Gray, for example, includes the *Chelone virgata* and *Chelone maculosa* of Dumeril and Bibron as varieties of the *Chelone mydas.*

Family—Fluvialia.

Genus—Trionyx.

The Chelonian Reptiles called "Soft Tortoises," forming the genus *Trionyx* of Geoffroy St. Hilaire,* and the family *Fluvialia* seu *Potamites* of MM. Duméril and Bibron,† resemble those of the genus *Chelone* (family *Marina* seu *Thalassites*, Dum. and Bibr.) in the extremity of the vertebral rib, or pleurapophysis, projecting freely from below the end of the connate costal plate,‡ and in having the plastron incompletely ossified; but they are characterised by the still more incomplete ossification of the margin of the carapace, which retains much of its primitive soft, cartilaginous state; and they are further distinguished by the reduced number of the toes—three on each foot—which are armed with claws, the other two toes serving to support a swimming web; the name of the genus has reference to this peculiarity.

The head is depressed, elongated, and, in the recent animal, the nostrils are prolonged into a short tube, terminated by a small fleshy appendage like an elephant's proboscis. The outer surface of the dermal bones of the carapace, and of the corresponding parts of the plastron, is variously sculptured, usually by sinuous grooves and rugosities, as if wormeaten; and to such a degree in some species, as to give the parts a tuberculate character. The cuticle is soft and flexible, not developed into scutes; and there are accordingly no impressions like those that indicate the presence of the "tortoise-shell" plates in the skeleton of the existing turtles and in the petrified plastrons and carapaces of the extinct species of the marine family.

"Hitherto," write the meritorious authors of the elaborate 'Erpételogie Générale,' one has not observed any species of this family (*Potamites*) in our European rivers; all those which have been described, and of which the habitat is known, have come from the streams, rivers, or great fresh-water lakes of the warmer regions of the globe." (Tom. ii, p. 469.) The beautifully-preserved evidences of the species about to be described, which have chiefly been obtained by the Marchioness of Hastings from one limited locality, attest the abundance of the *Trionyces* in the fresh-waters of our latitudes during the Eocene period of geology.

The characters by which MM. Wagler and Duméril have divided the species of

* Annales du Muséum d'Histoire Naturelle, tom. xiv.

† Erpétologie Générale, 8vo, tom. ii, p. 461.

‡ This character is well exemplified in the Marchioness of Hastings's unique and beautiful specimen of the *Trionyx rivosus*, T. XVIII *A*.

Trionyx, Geoffr., into two genera, are not such as can be decisively recognised in the fossil carapace. A difference of convexity of that part by which the "*Cryptopodes*" are said to differ from the *Gymnopodes,* is not one that the comparative anatomist and palæontologist would recognise as valid for the distinction proposed.

Upon the whole, the fossil specimens in which that character can be compared, agree rather with the *Gymnopodes* of Dum. and Bibr., but with a range of diversity which is exemplified by Tab. XVI*A,* and XVII. So much of the plastron as I have been able to compare, agrees likewise with the bones of that part in the *Gymnopodes,* but, in the absence of more certain characters, and with doubts as to the necessity or desirableness of the subdivision proposed for the recent species, I shall retain the name *Trionyx* for all the fossils that manifest, in their petrified remains, the characters of the Geoffroyan genus.

In the second part of my 'Report on British Fossil Reptiles' I showed that certain fossils of the Wealden formation and of the Caithness slate (new red sandstone) had been referred erroneously to the genus *Trionyx,* and that the only unequivocal remains of that genus which had been seen by me at that period (1841) were from Eocene deposits at Sheppy, Bracklesham, and the Isle of Wight, in which latter locality they were associated, as in the Paris basin, with remains of the *Anoplotherium* and *Palæotherium.*

I have since had the opportunity of examining fossil specimens of *Trionyx* from other localities, but always, however, from formations of the Eocene period, and I shall commence their description with one of the most perfect and beautiful examples of these Chelonites, which was obtained by the Marchioness of Hastings from the Eocene sand of the Hordwell Cliff, Hants.

TRIONYX HENRICI. *Owen.* Tab. XVI.

Report of the Seventeenth Meeting of the British Association, 1847, p. 65.

Although the characteristics of the genus are readily recognisable in fossil fragments of the carapace and plastron, from their comparative flatness and the sculpturing of the outer surface, the species of *Trionyx* are with difficulty determinable, if at all, from such specimens; and it is usually necessary to have a considerable part of the carapace, in order to ascertain its composition, contour, and degree of convexity. Some species, indeed, e. g. *Trionyx rivosus* (T. XVIII*A*), *Trionyx marginatus* (T. XIX*), together with the *Trionyx spinosus** and *Trionyx sulcatus* of Kutorga, would seem to be characterised by particular patterns of the irregular surface of the bones of the carapace, which character, therefore, a fragment may suffice to manifest; but this is not the case with the ordinary rugose and vermiculate species. Cuvier accordingly

* This is quite a distinct species from the *Trionyx spiniferus* of Lesueur.

admits, with respect to the portions of *Trionyx* found abundantly in the gypsum of the environs of Paris, associated with the Palæotheres, Anoplotheres, and other extinct animals of the Eocene epoch, that he could find nothing in those fragments to authorize him to fix their specific characters.* The compilers of the labours of palæontologists have, as usual, been affected by no such scruples, and have not hesitated to assume a knowledge, which Cuvier did not feel himself entitled to claim, viz. that of the fact of the specific distinction of the *Trionyx* of the Montmartre quarries: but I do not find that they have added anything to its history except the name of *Tri. Parisiensis*. It is probable, from the analogy of our own Eocene deposits, that more than one species of *Trionyx* may have left its remains in the Parisian localities of the corresponding geological formation.

The fossil remains of *Trionyx* from the tertiary deposits of the Gironde,† Lot-et-Garonne,‡ Montpellier, and Avary, were not sufficiently characteristic to permit the great anatomist and founder of Palæontology to infer more than the existence of the particular genus of fresh-water Chelonia in question in those formations. The only specimen of fossil *Trionyx* in which Cuvier recognised characters distinguishing it from the known existing species, is that which M. Bourdet first described§ under the name of *Trionyx Maunoir*, from the Eocene quarries at Aix. Cuvier has given reduced views of a large proportion of its carapace and half its plastron in the 'Ossemens Fossiles,' tom. v, pt. ii, Pl. XV, figs. 1 and 2. This description and the figure of the carapace serve to elucidate by comparison the characters of the more perfect specimen of *Trionyx* here described from the Eocene of Hordwell.

In the first place, the contour and proportions of the entire carapace of the *Tri. Henrici* differ from those of the *Tri. Maunoir*. The carapace of the *Tri. Henrici*, which is formed, as usual, by the neural plates ($s1$, $s2$, &c.) and eight pairs of costal plates ($pl1$—8), measures 10 inches 8 lines in length, and 11 inches 2 lines in breadth, in a straight line across the third ($pl3$) costal plate, where it is widest. In *Tri. Maunoir*, the neural plates (plaques vertébrales) rise a little above the plane of the carapace, as in the *Tri. ferox* (*Tri. carinatus*, Geoffr.‖): in the *Tri. Henrici* there is no trace of this carinate structure; the neural plates are flat, and on a level with the broad costal plates articulated with them; in which characters it resembles the *Tri. gangeticus*, Cuv., and *Tri. javanicus*, Cuv.

The first costal plate ($pl1$) is broader than it is long in *Tri. Maunoir;* in *Tri. Henrici* its breadth is little more than half its length, and decreases as it recedes from

* "Mais je n'ai rien trouvé dans ses débris qui m'autorisât à en fixer les caractères spécifiques." (Ossemens Fossiles, tom. v, pt. ii, p. 223.)

† Cuvier, tom. cit., pp. 225, 227.

‡ The skull of the *Trionyx* from this locality showed a slightly different profile from that of any of the existing species.

§ Bulletin de la Société Philomathique, 1821.

‖ Annales du Muséum, tom. xiv, pl. 4, 1809.

the neural plate. The second costal plate, on the contrary, is broader at its lateral than at its mesial end in *Tri. Henrici,* whilst its breadth is equal at both ends in the figure given by Cuvier of the *Tri. Maunoir.* The thickness of the costal plates, in proportion to their breadth, is shown in T. XIX*B,* figs. 4 and 5; the degree of projection of the connate rib from the inner surface of the costal plate is given in figure 6. The peripheral border of the carapace is not grooved in this species, as in the *Tri. circumsulcatus,* fig. 3.

The degree of transverse convexity of the carapace of the *Tri. Henrici* is the same as that of the *Tri. Ægyptiacus,* and as that attributed to the *Tri. Maunoir.**

The nuchal plate is wanting in Lady Hastings's specimen; the one which is figured in T. XVI, fig. 3, is from the same locality at Hordwell, but does not belong to the carapace, fig. 1, although it has probably belonged to one of the same species, from the contour of its hinder border.

The first neural plate (*s*1) does not project beyond the adjoining anterior borders of the first costal plates (*pl*1) as it does in *Tri. subplanus, Tri. ferox,* and *Tri. javanicus;* nor do those borders, as they recede from the neural plate, curve forwards beyond it, as in *Tri. javanicus*† and *Tri. coromandelicus.*‡

The anterior border of *Tri. Henrici* is slightly concave and gently undulated, as in the *Tri. Ægyptiacus,* and is also rough and sutural, showing that the anterior azygos or nuchal plate ("pièce impaire," Cuv.) had been immediately articulated with it, as it is in *Tri. Ægyptiacus.*§

The fossil specimen of the nuchal plate, figured in T. XVI, fig. 3, shows, by the sutural structure of its posterior border, that it articulated with the anterior sutural border of the carapace to which it belonged, and which, as already remarked, belonged probably to the species *Tri. Henrici,* though not to the individual the carapace of which is figured in T. XVI, fig. 1.

The neural plate (*n*1) is longer in proportion to its breadth, and the corresponding costal plates (*pl*1) are narrower at their extremities than in *Tri. Ægyptiacus.* The second costal plates (*n*2) are broader at their extremities than in *Tri. Ægyptiacus;* they resemble those in *Tri. subplanus.*‖

The first four neural plates in *Tri. Henrici* slightly expand posteriorly, and have their posterior angles cut off; the fifth (*n*5) is a narrow plate with entire angles; the sixth (*n*6) is expanded anteriorly, and has its anterior angles cut off; the seventh (*n*7) has also its anterior angles cut off, but is rounded behind, and, as it were, obliterated by the extension of ossification from the costal plates into the dermal cartilage above

* "Sa convexité transversale est telle, que la flèche de l'arc est moindre du cinquième de la corde." (Cuvier, Ossemens Fossiles, tom. v, pt. 2, p. 223.)

† Annales du Muséum, tom. xiv, pl. 3, *A.*

‡ Ibid., pl. 5, fig. 1.

§ Ibid., pl. 2, A, *a.*

‖ Ibid., pl. 5, fig. 2.

the neural spines. The eighth neural plate is wholly obliterated or superseded by a similar encroachment and union of the eighth pair of costal plates (*pl*8). Almost the same modification is represented by Geoffroy in the carapace of the *Tri. Ægyptiacus;** but the general proportions of the carapace of the *Tri. Henrici* are more like those in the *Tri. subplanus,* in which the eighth neural plate exists in the interspace of the eighth pair of costal plates, as it does likewise in *Tri. Mannoir.*

All the exterior surface of the expanded parts of the neural spines and ribs is roughened or sculptured with a moderately fine vermicular pattern, the undulatory grooves having a tendency to a concentric arrangement at the peripheral surface of the carapace, and in general passing uninterruptedly from one costal plate to another: the pattern is effaced from about one third of an inch of the border of the carapace, which presents a surface like that of a coarsely-woven cloth. The extreme border is rather suddenly bevelled or rounded off from above downwards, and is thinner than the border of the costal plates that articulates with the neural plates. The natural extent of the ordinary narrow extremities of the ribs cannot be determined from the present specimen of the *Tri. Henrici;* they form the usual slight relief along the middle of the smooth under surface of the connate costal plates; and do not subside at any part of their course to the level of the under or inner surface of the plate.

T. XVI, fig. 1, shows the upper surface of the carapace of the *Tri. Henrici,* half the natural size.

Fig. 2, in outline below, gives the curve and degree of transverse convexity across the middle of the carapace.

Fig. 3, the nuchal plate of apparently the same species of *Trionyx,* half the natural size.

T. XIX*B*, fig. 4, shows the outside view of the third costal plate, right side, natural size; fig. 5, sutural border of the same plate, showing its thickness and the degree of curvature; fig. 6, the peripheral border of the same plate with the connate rib.

All these specimens were discovered by the Marchioness of Hastings in the Eocene sand at Hordwell, and are preserved in her ladyship's Museum at Efford House, near Lymington, Hampshire. The species is dedicated to her ladyship's husband, Captain Henry, R.N.

In the figure of the carapace of the *Trionyx* (*Tri. subplanus*) in Cuvier's pl. xiii, fig. 5, 'Ossemens Fossiles,' tom. v, pt. ii, the costal plates do not bear the same numbers as the corresponding neural plates; the anterior costal plate is marked a_1, whilst the corresponding neural plate is b_2; the rib or pleurapophysis of the first dorsal vertebra, which is marked c_1, is short, and is applied to the under and fore part of the second rib which supports the first costal plate. In T. XVI, the dermal ossifications of the carapace bear the same letters and numbers as the homologous parts in the previous plates, and in the woodcut, fig. 1, p. 3.

* Ibid., pl. 2, *A.*

TRIONYX BARBARÆ. *Owen.* Tab. XVI*A*.

This species, like the *Trionyx Henrici*, is most satisfactorily and beautifully represented by an entire carapace in the collection of the Marchioness of Hastings, to whose indefatigable researches in the locality of the Eocene sand at Hordwell Cliff, its discovery is due, and by whose skill, tact, and patience it has been faithfully restored from its original fragmentary state.

The carapace is more slender in proportion to its length, and deeper or more convex in proportion to its breadth, than in the *Tri. Henrici*. In this species, as is shown in T. XVI, the breadth is greatest towards the fore part of the trunk; in the *Tri. Barbaræ* this is the narrower part, and increases in breadth towards the middle of the carapace (*pl*4).

The antero-posterior diameter or length of the nuchal plate is greater in proportion to its transverse diameter or breadth, and the arched ridge on its inner surface is less strongly developed than in *Tri. Henrici*. On the outer surface the smooth anterior border, where the plate would seem as if cut away obliquely to an edge, is more extensive in comparison with the rough, worm-eaten surface in the *Tri. Henrici* (T. XVI, fig. 3), or those in the nuchal plate of *Tri. incrassatus*, T. XVIII, fig. 1, *ch*. The median part of the anterior border is more deeply excavated, and the lateral borders less deeply dentated in the *Tri. Barbaræ*.

The whole of the posterior border of the nuchal plate is thick, sutural, and is articulated to the first neural plate and the anterior costal plates (*pl*1); the middle part extending backwards to unite with the neural plate, by which also *Tri. Barbaræ* differs from *Tri. Henrici*.

The first neural plate is shorter and broader in proportion to the length of the costal plates than in the *Tri. Henrici*, but presents a similar shape, the sides being parallel, and the posterior angles truncate; in the three succeeding neural plates the sides converge towards the anterior end, but the posterior angles continue to be cut off. The fifth neural plate is oblong and quadrangular, as in *Tri. Henrici*, T. XVI. In the sixth neural plate the fore part is the broadest, and its angles are truncate; the seventh is a subtriangular and not fully-developed plate; the corresponding pair of costal plates meeting behind it. The eighth pair of costal plates (*pl*8) similarly supersede and take the place of *s*8, by meeting and joining at the middle line, but the left is the broadest, not the right.

The first costal plate (*pl*1) is longer in proportion to its breadth (or antero-posterior diameter), which is also more equally preserved throughout its length than in the *Tri. Henrici*, and the connate smooth rib is less prominent on its under surface. The inner and anterior angles of this surface do not show the depression formed by the head of the vertical scapula, which is present in that part of the stronger *Tri. Henrici*.

A well-marked distinctive character is also afforded by the seventh costal plate (*pl*7), from which the free end of the connate rib projects at the anterior angle of the dilated end in *Tri. Barbaræ,* and the free border of that end describes a straight line transverse to the axis of the carapace.

The free borders of the eighth pair of costal plates are on the same transverse line, and the posterior part of the carapace is consequently truncate and straight.

The lateral margin of the carapace is more gradually bevelled down, and to a less obtuse edge than in the *Tri. Henrici.*

The length of the carapace of the *Tri. Barbaræ,* from the fore part of the first neural plate to the hind border, is nine inches and a half; the greatest breadth of the carapace, in a straight line across the fourth pair of costal plates, is nine inches ten lines. The total length of the carapace is eleven inches and a half.

The free end of the connate rib projects entire from the fifth, sixth, and seventh costal plates.

The character of the sculpturing of the outer surface of the costal plates is very similar to that in the *Tri. Henrici:* the tendency to the concentric arrangement of the raised lines is equally well marked in *Tri. Barbaræ,* and is accurately given in Mr. Erxleben's beautiful plate.

The carapace is not only more arched transversely, but it differs from that of *Tri. Henrici* in being slightly depressed along the middle line, as is indicated in fig. 2, T. XVI*A.*

This beautiful species of *Trionyx* is dedicated, with much respect, to its accomplished discoverer, Barbara, Marchioness of Hastings, and Baroness Grey de Ruthyn.

TRIONYX INCRASSATUS. *Owen.* Tab. XVII, XVIII, and XIX.

This species of *Trionyx*, from Eocene formations of the Isle of Wight, resembles in general form the *Tri. Henrici* of the Hordwell sand, but differs from it in the anterior internal angle of the first costal plate (*pl*1, T. XVII and XVIII) being cut off, like that of the second and succeeding costal plates: it also differs in the greater length of the second costal plate as compared with the breadth of its outer end, and in the greater breadth of the outer end of the sixth costal plate (*pl*6, T. XVII), the outer or terminal border of which is more convex. The nuchal plate (*ch,* T. XVIII) articulates with the whole anterior border of the first neural (*s*1) and costal plates (*pl*1), but sends backwards a process from near the middle of its posterior border, which fits into the space left between the truncated antero-internal angles of the first costal plates and the first neural plate. In this respect it resembles the nuchal plate of *Tri. Barbaræ* (T. XVI*A*), but the difference of general shape between this more delicately formed species, and the one under consideration, is well marked, and decisive as to their specific distinction. The anterior border of the nuchal plate of *Tri. incrassatus* is smooth, slightly channeled, and feebly emarginate at the middle part; the plate sends out three short, tooth-like processes on each side; the posterior angle forms a fourth process which articulates with the true costal part, or end of the second rib, connate with the first costal plate (*pl*1). The first neural plate (*s*1, T. XVIII) is rather broader in proportion to its length than in the *Tri. Henrici.* The second (*s*2) and third (*s*3, T. XVII) do not expand so much behind; the vermicular pattern is broken into distinct tubercles upon these plates. The posterior lateral sides of the hexagonal neural plates are relatively longer than in those of *Tri. Henrici.* The fifth neural plate (*s*5, T. XVII) extends backwards beyond the fifth pair of costal plates (*pl*5, compare with T. XVI) and articulates with the sixth pair of costal plates; but the eighth and part of the seventh neural plates are superseded by ossification, extending from the seventh and eighth pairs of costal plates to the median line, where those plates articulate with each other, as in the *Tri. Henrici* and *Tri. Barbaræ.* The inner surface of the nuchal plate (*ch*, fig. 2, T. XVIII) is divided by a transverse, slightly interrupted ridge, gently concave backwards, into two nearly equal parts; the posterior one being most excavated. The inner surface of the first costal plate (*pl*1, T. XVII and XVIII) presents the prominence (*c*2) left by the fracture of the vertebral end of the second rib, where it becomes connate with that plate, and also the oblique ridge (*c*1) formed by the attachment of the expanded end of the first short rib. The free end of the second rib (*c*2) is short, obtuse, depressed, convex above and flat below; the body of this rib has subsided to the level of the inner smooth surface of the costal plate, with which it has become completely blended. A small portion of the body of the second vertebra is preserved in connexion with the long neural arch, showing that it was slightly carinate at the under surface. The breadth of the third rib (*c*3), where it becomes connate with the second costal plate (*pl*2), is rather more than one third the breadth of that part of the plate; the rib at first sinks almost to the level of the under surface of the plate, and then gradually rises, increasing in breadth to its free extremity. The true pleurapophysial portions of the succeeding costal plates (4, 5, 6, 7, 8, and 9, T. XVII) are better defined by outline grooves, but their degree of prominence is slight, except in the last pair (9), which have been liberated from the superincumbent costal plates (*pl*8) before they reached their posterior borders.

The minute accuracy and beauty of Mr. Erxleben's lithographs supersede the necessity of further verbal description of these rare and singularly well-preserved fossils.

T. XVII gives an inside view of the almost entire carapace of the *Tri. incrassatus;* and T. XVIII gives an outside (fig. 1) and an inside view (fig. 2) of the fore part of the carapace of the largest individual of the same species of *Trionyx,* from the Isle of Wight, showing the nuchal plate (*ch*) in its natural articulation with the anterior neural and costal plates.

One character by which these carapaces differ from those of the *Tri. Henrici* or *Tri. Barbaræ* is the abrupt, almost vertical, border of the carapace, which is formed by the peripheral ends of the costal plates: these increasing in thickness as they approach that end, render the border characteristically thick: the specific name—*incrassatus*—has reference to this structure. The border is not grooved, and it is slightly produced above the projecting end of the subjacent rib, where it slopes a little down to the connate rib (T. XVIII, fig. 1). This structure will serve to distinguish a detached costal plate of the *Tri. incrassatus* from one of the *Tri. circumsulcatus* (T. XIX*B*, figs. 1, 2, 3); and the verticality and thickness of the margin will equally distinguish it from one of the *Tri. Henrici* or *Tri. Barbaræ*.

The chief value of the specimen (figured in T. XIX) is derived from the fact, that several other bones of the same skeleton were discovered with it; and these I next proceed to describe.

T. XIX, fig. 1, is the entosternal piece of the plastron, having the characteristic form of the chevron; it is broadest and most compressed at the median junction of the two crura, which increase in thickness and diminish in breadth as they diverge. The branches are relatively more slender than in the *Tri. Ægyptiacus** and *Tri. Javanicus*;† they resemble those of the *Tri. carinatus*‡ and *Tri. gangeticus*.§.

Fig. 2 2′ is the lower branch of the left episternal: it is slender, gradually tapering to a point, flattened above or on the inner surface, convex behind, grooved along the margin next the entosternal. This piece, in its length and slenderness, resembles the corresponding part in the *Tri. carinatus* and *Tri. gangeticus*.

Fig. 3 3′ is the left hyposternal and part of the left hyosternal; the latter (*hs*) includes the mesial border, showing the relative extent of the angular part that sends off the ridged tooth-like processes, which are two in number, the anterior one notched or subdivided. The exterior, connate, rough, and tuberculate dermal plate stops at the base of these processes. The hyposternal (*ps*) has the nearest resemblance to that of the *Tri. gangeticus* figured by Cuvier,‖ but differs by the number of short toothed processes from its median and inferior border, and by the more slender base supporting the two long, lateral, striated, pointed processes. The tuberculate dermal plate covers all the exterior of the hyposternal to the roots of the pointed processes. The notch for the reception of the xiphisternal is rounded at the bottom.

Fig. 4 shows the long, rib-shaped, but straight scapula (51); its head forms two thirds of the glenoid cavity for the humerus; the body, flattened behind, convex in front, gradually contracts as it ascends, and terminates in an obtuse point; the

* Geoffroy, loc. cit., pl. 2, fig. B, *o*.

† Ibid., pl. 3, fig. B, *o*.

‡ Ibid., pl. 4, fig. B, *o*.

§ Cuvier, Ossemens Fossiles, tom. v, pt. ii, pl. 12, fig. 46.

‖ Loc. cit.

clavicular process (58) is shorter than the scapula, and slightly expands at its extremity. Both parts are longer and more slender than the homologous ones of the recent *Trionyx* figured by Cuvier.*

Fig. 5. The coracoid has the expanded, slightly curved form characteristic of the genus; it is not so broad as that figured by Cuvier.†

Fig. 6 is the iliac bone, short, thick, curved, subcompressed, attenuated and striated at its sacral extremity; the enlarged articular end is divided into three facets: two oblong and rough for sutural junction with the ischium and pubis; one smooth, and the smallest of the three, for the acetabulum.

Fig. 7 is the almost entire right femur; its convex, long oval head, bends inwards from between the two trochanters, of which the external and largest is broken off. The shaft bends backwards, and gradually expands to the feebly divided convex condyles. All the characteristics of the modifications of the femur in the *Trionyx* are here preserved.

Fig. 8 is a claw-bone, natural size.

Fig. 9 9′ 9″ are three views of the sixth cervical vertebra of the same *Trionyx*. This may be recognised by the broad, depressed, posterior surface of the centrum, partially divided into two cavities, side by side (*c*′); the seventh cervical has the two cavities there quite separated from each other; the fifth and preceding cervicals have the posterior surface of the centrum with a single cavity; so that the sixth cervical is the only one which has a single convexity in front (*c*, fig. 9′), and a double concavity (*c*′, fig. 9″) behind. The body is long, slender, compressed in the middle, with one median inferior ridge anteriorly, and a pair of inferior ridges posteriorly ending in hypophysial tuberosities (fig. 9, *yy*), which support, as it were, the posterior articular cups. A short, obtuse diapophysis projects from each side of the fore part of the centrum. The prezygapophyses (*z*) support slightly convex, oblong, articular surfaces; the zygapophyses (*z*′) are long, diverge, and support concave, oblong surfaces looking downwards. There is no spine; the neural arch is complete above the middle third of the centrum, the canal expanding towards both its wide, oblique outlets; this modification of course relates to the great extent of motion between contiguous vertebræ, and the necessity for providing against compression of the myelon during their rapid inflections and extensions.

The specimens of *Tri. incrassatus* here described are preserved in the Museum of the Marchioness of Hastings, by whose kind and liberal permission they, with other rare Chelonites, have been described and figured for the present Monograph.

* Loc. cit., pl. 12, fig. 4.

† Loc. cit., pl. 12, fig. 4.

TRIONYX MARGINATUS. *Owen.* Tab. XIX+.

A more obvious character than that pointed out at the peripheral border of the costal plate in *Trionyx incrassatus,* and serving better and more readily to determine such elements of the carapace, is the ridge with minute parallel striæ, which extends along the upper surface, close to the anterior and posterior borders of the costal plates in the species of *Trionyx* which I have on that account distinguished by the specific name of *marginatus.*

Mr. Erxleben has well given this character in the reduced view of the carapace (T. XIX+).

The border-pattern gradually becomes narrower and fades away before it reaches the outer end of the costal plates; it is also wanting on the anterior border of the first costal plate (*pl*1), and on the posterior border of the last (*pl*8).

The outer ends of the costal plates, which constitute the greater portion of the periphery of the carapace, are at first slightly bevelled off, and then vertically truncate; the sloping or bevelled part having the fine fibrous surface, which I have compared to coarse linen cloth. The vertical part of the border is slightly excavated in the fifth and sixth costal plates, but not so deeply as in the *Tri. circumsulcatus,* nor is the margin so thick in proportion to the length of the plate.

The neural plates are relatively smaller, in comparison to the costal plates, than in any of the foregoing species, but they agree in number; the eighth being suppressed, and the seventh reduced, in the same proportion as in *Tri. Henrici* and *Tri. Barbaræ,* by the median union of part of the seventh pair and of the eighth pair of costal plates. The fifth neural plate presents a simple oblong quadrilateral figure; the four neural plates in advance are six-sided, the two additional and shortest sides being formed by the truncation of the posterior angles; the sixth and seventh plates, on the contrary, have their anterior angles cut off. This modification in the form of the neural plates, and in their mode of juncture with the costal plates, relates to the opposite curvatures or inclinations of the costal plates, in the direction of the axis of the carapace: the anterior ones bending forwards, the posterior ones backwards, in addition to the curve common to all but the last pair of plates, transversely to the axis of the carapace, with the concavity downwards or towards the thoracic-abdominal chamber. The anterior internal angle of the second, third, and fourth costal plates is cut off; the posterior internal angle of the sixth, and both internal angles of the fifth pair of plates (*pl*5).

In these modifications of the form of the neural and costal plates, the *Tri. marginatus* agrees with the *Tri. Henrici* and *Tri. Barbaræ,* and differs from the *Tri. incrassatus,* in which all the neural plates but the seventh are six-sided, with the posterior internal angles truncated. Each of the costal plates, therefore, of the fifth pair, in the *Tri. incrassatus,* differs from those of the three other species of *Trionyx* here described, in having only the antero-internal angles truncated, instead of both these and the postero-internal ones.

In the form and general proportions of the first pair of costal plates, the *Tri. marginatus* shows an intermediate character between the *Tri. Henrici* and *Tri. Barbaræ;* in the great breadth of the peripheral end of the seventh pair of costal plates it differs in a well-marked degree from both species, and especially from the *Tri. Henrici,* which it most resembles in its general contour. In the *Tri. incrassatus* the seventh costal plates maintain nearly an uniform breadth from end to end.

The antero-posterior diameter of each of the triangular plates of the last costal pair exceeds the transverse diameter, whilst these proportions are reversed in *Tri. Henrici;* the difference in part depending on the different form of the posterior border of the carapace in the *Tri. marginatus,* which is truncated; the free borders of the last costal plates forming a straight transverse line. The marginal pattern of the costal plates may be traced in a slighter degree round the neural plates.

The reticular sculpturing is better defined, and of a coarser pattern in the *Tri. marginatus* than in any of the previously defined species.

The middle line of the carapace is slightly depressed, as in the *Tri. incrassatus.* The general degree of convexity of the carapace, which is less than that in the *Tri. Henrici* and *Tri. Barbaræ,* agrees also with that of the *Tri. incrassatus.*

The length of the carapace from the fore part of the first neural plate is eleven inches; its greatest breadth, across the suture between the third and fourth neural plate, is twelve inches.

This species is from the eocene deposit at Hordwell Cliff, Hampshire: it was discovered by the Marchioness of Hastings, and is preserved in her ladyship's collection at Efford House.

TRIONYX RIVOSUS. *Owen.* Tab. XVIII*A*.

This beautiful species of *Trionyx,* also discovered by the Marchioness of Hastings in the Eocene beds at Hordwell Cliff, has fortunately a characteristic pattern of sculpturing, which, like that in the *Tri. marginatus,* would serve for the determination of detached portions of the carapace. Any of the costal plates, for example, of the posterior half of the carapace, figured in Tab. XVIII*A*, might be distinguished by the sub-parallel longitudinal, and more or less wavy ridges, superadded to the more common reticulate sculpturing from the homologous parts of the carapace of any of the preceding fossil species of *Trionyx,* and, so far as I have yet seen, from any of the recent species.

The ridges in question, it will be understood, are longitudinal in respect of the entire carapace; they would be transverse to the long diameter of the detached costal plate; they become more wavy as they recede from the neural plates. Of these only the sixth (*s*6) has been preserved in the specimen described; it differs in shape from that in any of the foregoing species, in being broader in proportion to its length; its greatest breadth being, as in *Tri. Henrici*, *Tri. Barbaræ*, and *Tri. marginatus*, across its anterior fourth part. The fifth neural plate, as in the species above cited, has been an oblong quadrate one, the fourth plate has had its postero-internal angles cut off, contrariwise to the sixth. The fifth costal plates have accordingly the same character of truncation of both their internal angles, though less marked anteriorly. A portion of the seventh and the entire eighth neural plates have been superseded, as in the other fossil *Trionyces*, by the median growth and junction of the seventh and eighth pairs of costal plates.

In the forms and proportions of these plates the present species agrees best with the *Tri. Henrici* and *Tri. incrassatus;* the latter species differs from it by the breadth and convexity of the sixth costal plates (*pl*6). The smooth connate ribs (5, 6, 7), shown on the under surface of the costal plates, T. XVIII*A*, fig. 2, preserve a more uniform diameter, and do not expand in the degree shown in the *Tri. incrassatus*, T. XVII, 5, 6, 7; the rib (8) attached to the costal plate (*pl*7) is straighter in *Tri. rivosus* than in *Tri. incrassatus*.

The projecting extremities of the ribs are beautifully preserved in the specimen of *Tri. rivosus* here described: their greater length, as compared with those attached to the fifth, sixth, and seventh costal plates in *Tri. Barbaræ* (T. XVI*A*), depends upon the nonage of the present specimen, which is figured in T. XVIII*A* of the natural size.

The peripheral borders of the costal plates are bevelled off obliquely from above downwards, and project a little where they join the end of the subjacent rib; the surface of this is finely and longitudinally striated. The reticulate sculpturing of the carapace extends to the sloping peripheral border, as it does to the vertical thick border of the carapace in *Tri. incrassatus;* it is not separated from the border by a marginal decussating fibrous surface, as in *Tri. marginatus*, *Tri. Henrici*, and *Tri. Barbaræ*.

The longitudinal ridges of the carapace, which form the chief distinctive character of the *Tri. rivosus*, offer an interesting though slight approach to the main feature of the carapace of the Luth or coriaceous soft turtle (*Spargis coriacea*); but in this existing species the longitudinal ridges or carinæ are straighter and more elevated, and the surface of the carapace is smooth at the interspaces. The less parallel and wavy course of the ridges in the present extinct *Trionyx* give a sinuous course to the intercepted spaces, like the furrows left by streams of water which have temporarily coursed over a sandy surface, whence the name "rivosus" proposed for the species.

TRIONYX PLANUS. *Owen.* Tab. XIX *C.*

This species, like the *Tri. rivosus*, is represented by the posterior part only of the carapace, but the distinguishing characters are so well marked in it as to leave no doubt respecting the difference of the species from that of any of the above-defined *Trionyces.* The specimen consists of the last four pairs of costal plates, which are flat, with a coarse reticulate pattern on their upper surface, worn away towards the median end of the plates into a fossulate pattern, or detached pits; the reticulate sculpturing extends to the peripheral border of the costal plates, which is almost vertically cut down, and is scarcely at all produced where the attached rib projects: there is no marginal pattern along the anterior or posterior borders of the costal plate. The ribs are more neatly defined from the superincumbent costal plates than in any of the foregoing species, except, perhaps, the *Tri. rivosus.* The *Tri. planus* differs from them all in the complete obliteration of both the seventh and eighth neural plates, and by a partial obliteration of the sixth neural plate. This arises from a similar encroachment of ossification from the postero-internal borders of the sixth costal plates, upon the dermal cartilaginous matrix of the sixth neural plate, to that which happens in respect of the seventh neural and costal plates in the other *Trionyces*; whilst the whole of the seventh neural plate is superseded, as well as the eighth, and by the same encroachment of the corresponding pairs of costal plates.

These modifications and varieties of the osseous parts of the carapace are very significative of the essentially dermal nature of those parts, and show the small value and deceptive tendency of that developmental character on which Cuvier and Rathké have relied in pronouncing the neural plates to be developed spinous processes of vertebræ, and the costal plates to be expanded ribs. The connation of the seventh and eighth neural plates with the corresponding costal plates does not destroy their essential nature and existence, though it seems to make them part of the costal plates, any more than that connation with the neural arch in other *Chelonia* which seems to make them spinous processes.

Another distinctive character in the *Tri. planus,* as compared with the foregoing Eocene species, is the very close union, almost amounting to confluence, between the seventh and eighth costal plates of the same side, the original suture between which has been almost obliterated at their inferior surface.

In this character the *Tri. planus* resembles the *Tri. ferox,* Schweigger (*Gymnopus spiniferus,* Dum. and Bibr.), and *Tri. muticus,* Lesueur, but it differs from both by the flatness of its carapace, and the absence of any keel-like elevations upon its outer surface.

The middle of the posterior border of the carapace is slightly concave.

The specimen here described and figured was obtained by the Marchioness of

Hastings from the Eocene sand of Hordwell Cliff, and forms part of her ladyship's rich and instructive collection.

With the above portions of carapace, and apparently belonging to the same species of *Trionyx*, were found the two osseous plates, naturally and suturally united together, which are figured in T. XIX*D*, fig. 6, *hs, ps* ; they present a similar coarse reticulate pattern on their external surface, with the same tendency to a concentric arrangement of the raised parts towards the periphery of the plate; their inner surface is smooth, slightly undulating, but upon the whole a little concave, and without any indication of adherent ribs. I regard them therefore as parts of the plastron, and they agree best with the hyosternal and hyposternal elements of the right side; yet differ in having no tooth-like processes extending from the inner border, which is convex instead of being concave, where the two elements join each other.

At the inner and anterior angle of the hyosternal there is, however, the fractured base of what was probably a tooth-like process; and there is similar evidence of such processes having extended from the posterior angle of the hyposternal, close to what I take to have been part of the notch for the xiphisternal.

These fragments at least show that the *Tri. planus*, or whatever species from Hordwell they belonged to, must have had a very different form of plastron from that of the *Tri. incrassatus* of the Isle of Wight, of which the conjoined hyosternal and hyposternal bones are figured in T. XVII*A*, figs. 3 and 3′, and from that plastron of which the hyposternal piece, from Bracklesham, is figured in T. XIX*D*, fig. 7.

TRIONYX CIRCUMSULCATUS. *Owen.* Tab. XIX*B*, figs. 1, 2, and 3.

It may seem to have been hazarding too much to found a species on a single character when manifested by a single fragment of a carapace, which is all that at present represents such species; yet the character in question is so strongly marked, and so different from that of the same part of the carapace of any other fossil or recent species of *Trionyx*, that there appears to be no other alternative than to regard it as specific. The character in question is the groove or canal which is excavated in the thick vertical margin of the expanded free extremity of the fourth costal plate of the left side, figured in T. XIX*B*, figs. 1, 2, and 3. The vermicular sculpturing of the external surface of this plate, and its proportions and connexions with the connate rib, prove it to belong to the carapace of a *Trionyx*.

Previously to receiving this specimen from Lady Hastings, my attention had been drawn to the different modes in which the extremities of the costal plates of the different species of *Trionyx* were modified, in order to form the border of the carapace; sometimes obliquely bevelled down to an edge, as in the *Tri. Barbaræ* and the fragment of the *Trionyx pustulatus*, from Sheppy, figured in T. XIX*B*, 7—10; sometimes cut down vertically, or nearly so, as in the thickened border of *Tri. incrassatus;* sometimes with a marginal modification of the external sculpturing before the edge was formed, as in *Tri. marginatus;* sometimes without any such border-pattern, as in *Tri. rivosus.* But whatever character the border of a carapace has presented, has been constant in the same species, in which it is modified only at the fore part of the border formed by the nuchal plate, and at the back part formed by the short and small eighth pair of costal plates.

From this, therefore, it is to be inferred that the peculiar modification presented by the free border of the fourth costal plate, T. XIX*B*, fig. 3, was repeated in all the other costal plates, excepting, perhaps, the last pair; and consequently that the carapace was almost entirely surrounded by a thick, vertical border, deeply grooved,—a character which is expressed by the specific name *circumsulcatus*, selected to denote the Eocene *Trionyx*, represented by the fragment of the carapace here described.

This fragment, which consists as before said of the fourth costal plate of the left side, presents the common reticulate pattern of its external sculptured surface, but with some modifications not presented by the before-described species; the meshes are smaller near the ends of the plate than at its middle part, and the network is finest near the peripheral end. In the *Tri. marginatus* more particularly, and in a minor degree in *Tri. incrassatus*, the *Tri. Henrici*, and *Tri. Barbaræ*, we observe the raised parts of the network assuming a linear arrangement, more or less concentric, with the circumference of the carapace; but there is nothing of the kind observable in the *Tri. circumsulcatus.* In this species also the outer surface of the costal plate presents a distinct though slight double curvature; the usual convexity being changed into a concavity near the peripheral border: and, as the inner surface presents the usual uniform concavity, the peripheral part of the plate suddenly augments in thickness as it approaches the grooved border. (See fig. 2.) The character which distinguishes the *Tri. incrassatus* from *Tri. Henrici*, *Tri. Barbaræ*, and *Tri. rivosus*, is exaggerated in *Tri. circumsulcatus*, and there is added to it the groove, of which there is no trace in *Tri. incrassatus*, and but a feeble one in the fifth and sixth plates of *Tri. marginatus.*

The connate rib is almost wholly sunk into the substance of the supercincumbent costal plate in the *Tri. circumsulcatus;* it is less prominent than in any of the foregoing species, especially at its distal part, which is also less expanded than in the *Tri. incrassatus.* The free extremity of the rib is entire, and is very short, as is shown in figure 1.

TRIONYX PUSTULATUS. Tab. XIX*B*, figs. 7, 8, 9.

The contrast which the fragment above referred to, of apparently the homologous costal plate to the one last described, presents in the character of its peripheral border, and in the prominence of the connate extremity of the rib on its under surface, is so great, as must impress the value of such characters upon the palæontologist. The outer surface of the present fragment presents a well-marked reticulate, or rather pustular, pattern, but a coarser one than in the *Tri. circumsulcatus*. The reticulation is continued to the beginning of the bevelled border in fig. 7, which slopes gradually to an edge; beneath which the free end of the rib projects. The *Tri. rivosus* most resembles the present fragment in this character.

The fragment is from Sheppy. I strongly suspect it to belong to a species distinct from any of those from Hordwell; and, in the hope of acquiring more illustrative specimens, the attention of collectors is directed to it by the specific name and the figure here given.

TRIONYX. *Sp. ind. Bracklesham.*

The left hyposternal bone of the *Trionyx* from Bracklesham (figured in Tab. XIX*D*, fig. 7) resembles that from the Hordwell Eocene, referred to *Trionyx planus* (fig. 6, *ps*), in the convexity of the inner border at that part where it is concave in the *Tri. incrassatus* (T. XIX, fig. 3, *ps*); but it differs from the *Tri. planus* in being uniformly convex as far as the xiphisternal notch, and is not indented before forming that notch, as it is in the *Tri. planus* (T. XIX*D*). The present hyposternal shows also very plainly the base of a fractured tooth-like process of the subjacent hæmapophysis projecting from the inner border, where there is no such trace of a process in the *Tri. planus*. There are also the bases of a tooth-like process on both sides of the xiphisternal notch, and at the posterior outer angle of the hyposternal bone. The external border of the bone in advance of these processes is longer and straighter than in the corresponding part of the hyposternal of the *Tri. incrassatus*.

The species of *Trionyx* from Bracklesham cannot, however, be safely defined until the characters of its carapace are known. The present specimen forms part of the valuable and instructive collection of Frederick Dixon, Esq., F.G.S.

Family—PALUDINOSA.

This family, if regard were had to the number of species it contains, might be deemed the typical one of the order *Chelonia*. But in the series of extinct species, from the particular formation of Great Britain, to which the present Monograph is restricted, the number of marsh tortoises is small in comparison with those that were more truly aquatic (*Fluvialia*), and which inhabited the sea (*Marina*); and such a result might have been anticipated from the nature of their matrix, as it is elucidated by other classes of fossil animals, the remains of which are found in the London clay.

The feet of the *Paludinosa* have the digits comparatively free; more than three toes, as in *Tetronyx*, Lesson, and usually all five, are armed with claws, and are united together by a web only at their base; but the extent of this web and the length and flexibility of the digits vary in the different species and sub-genera, and accordingly they manifest various degrees of aptitude for swimming, or for climbing the banks of the streams or marshes which they habitually frequent, and for walking on dry land.

The costal plates extend, in the mature individuals, to the ends of the ribs, and articulate with the marginal plates; the dermal pieces of the plastron are co-extensive with the abdominal integument, and unite together by suture so as to form an unbroken expanse of bone; the sides of which, formed by part of the hyosternals and hyposternals, unite with a corresponding proportion of the lateral borders of the carapace. There is a gradation in the degree of convexity of the carapace, and in the angle at which the sides of the plastron bend up to join the carapace, which progressively brings the marsh tortoises nearer to the true land tortoises (*Terrestria*), and some of the steps in this progression of affinities are illustrated by the fossils from the London clay.

Those that, by the flatness of their carapace and plastron, depart least from the fluviatile forms of the order will be first described.

Genus—Platemys.

Platemys Bullockii. *Owen.* Tab. XXI.

Report on British Fossil Reptiles, Trans. British Association, 1841, p. 164.

Amongst the fossil Chelonians of the London clay, the portable dwelling-house of which was provided with side walls as well as a floor and roof, are some tolerably large species, remarkable for the lowness of the roof of their abode, and especially for the flatness of its floor.

A rigid comparison of the numerous species of the marsh-dwelling Chelonians, which the active researches of naturalists have brought within the domain of science, has led to their classification into several groups, to which generic or sub-generic names are attached, and the fine preservation of the characteristic part of the skeleton of the specimen from Sheppy, figured in Tab. XXI, gives the opportunity for determining to which of these subdivisions of the genus *Emys* of Bronguiart that specimen belongs.

In my 'Report on British Fossil Reptiles,' the result of these comparisons, as regards the present fossil, were simply indicated by the sub-generic name, and I confined myself to a description of the specific distinctions noticeable in the only example I had then seen.

The present species differs from all those to which MM. Dumeril and Bibron restrict the term *Emys*,* by the presence of a thirteenth scute—the intergular one (*ig*. T. XXI) upon the plastron; from the genera *Cistudo* and *Kinosternon* it differs by the absence of any moveable joint between the parts of the plastron; from the *Tetronyx* by the rounded anterior border of the plastron, and the greater number of scutes that have left their impressions upon it: it resembles the genus *Platysternon* in the flatness of the plastron and the horizontality of its lateral prolongations; but it differs from the only known species of that genus in the contour of the sternum, which is elliptical and rounded in front, and has the lateral prolongations one third the length of the entire sternum. It has also the intergular scute, which is absent in the *Platysternon*, as in the *Emydes* of Dumeril and Bibron. The presence of this scute, so plainly indicated at *ig* in the petrified plastron from Sheppy, together with the impressions of six pairs of the more constant scutes of the plastron, indicate that the depressed form of the probably estuary terrapene to which that plastron belonged, has appertained to the section which the eminent French Erpetologists above cited have called *Pleurodères*, or those that could retract their neck beneath the side only of the anterior aperture of their thoracic abdominal case.

From the genus *Peltocephalus* the fossil under comparison differs by the marginal position of both gular (*gu*) and intergular (*ig*) scutes, and by the slight narrow emargination of its posterior extremity (*xs*). An outline of the natural size of this emargination is added in the plate.

It more nearly resembles the *Podocnemys expansa* in the forms and proportions of the plastron scutes; but the three anterior ones (*gu*, *gu*, and *ig*), are not wedged in (*enclavées*) between the humeral scutes (*hu*), but are on a plane anterior to them.

The form and proportions of the plastron in certain species of the *Platemys*, Dumeril and Bibron, and the number and relative position of the scutes which covered it, offer the nearest resemblance to those of the present fossil, and, with the results of the foregoing comparisons, have determined my reference of the specimen in question to that genus.

Like the *Platemys Spixii* (*Emys depressa* of Spix), *Platemys radiolata*, *Platemys gibba*, and some others of the genus, the sternum is rounded at its anterior border, and notched at its posterior and narrower extremity.

The intergular scute (*ig*) which crosses the median suture of the episternals (*es*) is sub-pentangular and larger than either of the gular pair; its point encroaches a little upon the entosternal bone (*s*). The gular scutes (*gu*) are triangular, and, with the intergular one, cover the anterior border of the plastron.

The humeral or brachial scutes (*hu*) are inequilateral quadrate plates; the pectoral scutes (*pe*) and the abdominal scutes (*ab*) are transversely oblong and quadrate. The femoral scutes are inequilaterally quadrate, the posterior external angles being prolonged and rounded off. The anal scutes would be sub-rhomboidal were the posterior

* Erpétologie Générale, 8vo, 1835, tom. ii, p. 232.

end of the plastron entire. There are impressions of three scutes—the axillary, the inguinal, and a supplementary one,—upon each lateral prolongation of the plastron, covering the suture between this and the marginal plates of the carapace (*aa*), in which the present fossil resembles the *Platysternon* or large-headed *Emys* of China; but the lateral walls are relatively longer, being equal in antero-posterior extent to one third the same diameter of the entire plastron; whilst in the subgenus *Platysternon* they are less than one fourth. The general form of the plastron is also very different; in the *Platysternon megacephalum*, e. g. the plastron has an oblong quadrilateral figure, with an open-angled notch behind.

Retaining, then, the present species in the genus *Platemys*, as defined by Duméril and Bibron, we find that it enters into that small minority of the group in which the plastron is rounded instead of being truncate anteriorly.

In the present remarkable fossil the plastron forms almost a long ellipse, the hinder, division being very little narrower, but tending to an apex, which is cut off by a shallow emargination. The lateral walls, of the length above defined, extend outwards almost parallel with the plane of the sternum, and expand to join by a wavy or rather zigzag suture the marginal plates; six of these (*a a a a a a*) are preserved on each side; their lower sides form a very open angle with the lateral walls: but the fractures of these parts indicate that their horizontality may be in part due to accidental pressure.

The anterior part of the entosternal (*s*) is bounded by two nearly straight lines, converging forwards at an angle of 65°, with the apex rounded off; the posterior contour of this bone is nearly semicircular. The length of the entosternal is two inches ten lines; its breadth three inches seven lines; the forms and relative positions of the other elements of the plastron are sufficiently illustrated by Tab. XXI: *es, es* marks the extent of the left episternal; *hs, hs* are the hyosternals; *ps* the hyposternals; *xs* the xiphisternals.

The chief peculiarity of this plastron is the intercalation of a supernumerary piece of bone, bearing the letters *pe* and *ab* between the hyosternal and hyposternal elements on each side; so that the middle third of the plastron is crossed by two transverse sutures instead of one; each suture being similarly interrupted in the middle by an angular deflection from the right, half an inch back, to the left side.

The extremities of the transverse sutures terminate each at the apex formed by the inner or lower border of the parallel marginal plates. The first or anterior of these sutures is distant from the anterior margin of the plastron six inches five lines; the second suture is distant from the same margin eight inches nine lines; the right half of the suture, which is a few lines in advance of the left, is the part from which these measurements are taken.

Since this deviation is rare, it having been noticed for the first time in the original description of the present specimen, a naturalist, not having the specimen at hand for comparison, might at first be led to suspect that the transverse impressions of the second (pectoral) or third (abdominal) pairs of scutes had here been mistaken for a suture; but due care was observed to avoid this error; the scutes of the plastron have left obvious impressions at *pe*, *fe*, which prove that they were in the same number as in the Platemydians generally, and were quite distinct from the sutures in question.

Thus the intergular scute (*ig*) is in the form of an ancient shield; the gular scutes (*gu*) are small inequilateral triangles, with their posterior border parallel with that of the succeeding pair of scutes. The posterior transverse boundary of these,—the humeral scutes (*hu*)—crosses the plastron four inches and a half from its anterior margin; that of the pectoral pair of scutes crosses at seven inches and a half from the anterior border, and between the two transverse sutures; that of the abdominal pair (*ab*) at ten inches distant from the anterior margin, and about one inch and a quarter behind the second transverse suture; passing straight across the plastron between the posterior concave margins of the lateral wall. The posterior boundary of the fifth or femoral pair of scutes (*fe*) inclines obliquely backwards from the median line, as usual; it is three inches behind the preceding transverse impression.

It is in the interspace of these impressions that traces of the transverse suture between the hyposternals and xiphisternals are obvious, about four inches from the posterior extremity of the plastron. If these traces were not so obvious, it might be supposed that the xiphisternals were of unusual length, entering into the formation of the lateral wall, and extending backwards from the second transverse suture to the end of the plastron; but this disproportion would be hardly less anomalous than the existence of the additional pair of bones intercalated between the hyo- and hyposternals which the present fossil evidently displays.

In most of the existing large *Emydes* and *Platemydes*, the median transverse suture traverses the plastron a little behind the third pair of scutes, and so crosses the fourth or abdominal pair (*ab*, *ab*); and according to this analogy, the second transverse suture in the fossil agrees with the single one ordinarily present, and has most right to be regarded as the normal boundary between the hyo- and hyposternals. One of the most distinctive characters of the present extinct *Platemys* is, therefore, the division of each hyosternal into two, the plastron consisting of eleven instead of nine pieces; if the very interesting anomaly which it displays be not an accidental or individual variety. Viewed in the latter light, its explanation is suggested by that homology of the hyosternals and hyposternals which determines them to be connate and expanded abdominal ribs (hæmapophyses), and thus we may view the oldest of the known Platemydians as exhibiting, like many other extinct forms, a nearer approach to the more typical condition of the abdominal ribs, as they are shown, e. g. in the *Plesiosaurus*. Whereas, on Geoffroy's hypothesis, that the plastron is the homologue of the sternum of the bird, it would be a further deviation from that type.

The fine example of *Platemys Bullockii*, here described and figured, was purchased for the British Museum at the sale of Mr. Bullock's collection.

I am happy in the opportunity of expressing my acknowledgments to Charles König, K.H., F.R.S., for the urbanity with which every requisite facility was afforded.

PLATEMYS BOWERBANKII. *Owen.* Tab. XXIII.

Report on British Fossil Reptiles, Trans. British Association, 1841, p. 163.

This species is represented by a fine specimen exhibiting not only the plastron (fig. 2), but likewise a great portion of the carapace (fig. 1), from Sheppy, in the rich collection of the fossil remains from that island in the possession of J. S. Bowerbank, Esq., F.R.S. It equals in size the *Platemys Bullockii*, in the British Museum, but differs in the absence of the finely punctate character of the exterior surface of the bones; in the greater antero-posterior extent of the lateral walls, and the longer curves which they form in extending from the body of the plastron.

The carapace (fig. 1) presents the same equality of breadth of the neural plates (s_2—s_7) as in the *Emys testudiniformis;* but they diminish more rapidly in length as they recede in position; and the whole carapace is much more depressed; it is flat along its middle tract. The sixth neural plate (s_6) is a hexagon of nearly equal sides; the seventh (s_7) is a pentagon; the mesial or vertebral ends of the seventh pair of costal plates (pl_7) meet and unite behind it, so as to conceal or supersede the eighth neural plate. In the circumstance of the neural plates decreasing in length without losing breadth, as well as in the mutual junction of the seventh costal plates, the present fossil resembles the Sheppy carapace from Mr. Crow's collection, which Cuvier has figured, and which may, therefore, have belonged to the present species of *Platemys.*

The plastron (fig. 2) is thirteen inches in length and ten inches in breadth; it is rather broader before than behind, rounded at the anterior border, with a shallow emargination at the middle of the posterior border, but wider than in the *Platemys Bullockii,* and with the angles on each side rounded off. The under surface is nearly flat, slightly convex at the fore part, and as slightly concave behind. The lateral walls uniting the plastron to the carapace are five inches in antero-posterior extent.

The entosternal (*s*) resembles that of the *Platemys Bullockii* in general form, but is longer than it is broad, instead of the reverse proportions. The two anterior sides meet at a right angle. The episternals (*es*) are broadest behind. The middle part of the plastron is almost equally divided between the hyosternals (*hs*) and hyposternals (*ps*). There is a trace of the intercalary piece (*hp*), which is seen extending across the plastron of the *Platemys Bullockii;* here it is wedged into the outer interspace of those bones, like one of the external portions of the composite abdominal ribs in the Plesiosaur. In the relative length of the lateral walls the *Platemys depressa* most resembles the present species.

Genus—Emys.

Emys testudiniformis. *Owen.* Tab. XXIV.

Report on British Fossil Reptiles, Trans. British Association, 1841, p. 161.

Emys de Sheppy. *Cuv.* (?)

From the preceding genus of the *Chelonia paludinosa* the present species differs in the depth of the bony cuirass, the convexity of the carapace, and the concavity of the plastron (T. XXIV, fig. 6). The more immediate affinities of the present fossil are elucidated by the comparison of the points of structure which it displays with the anatomical characters of the carapace of the *Platemys* and *Testudo.*

The specimen, on which the species here called *Emys testudiniformis* is founded, includes a large proportion of the first, second, third, fourth, fifth, and sixth, with a fragment of the seventh costal plates of the left side; a small proportion of the second, third, fourth, fifth, and sixth neural plates; the hyosternals and hyposternals, and part of the entosternal bones of the plastron.

The first costal plate is one inch ten lines in greatest breadth, one inch five lines broad at its junction with the neural plates, and four fifths of the vertebral margin is articulated with the second neural plate; one fifth part, divided by an angle from the preceding, joins a corresponding side of the lateral angle of the third neural plate; in this structure it resembles both the genus *Testudo* and some species of *Emys.*

The third, fourth, fifth, and sixth neural plates are of equal breadth, as in *Emydes;* not alternately broad and narrow as in the *Testudines;* they are likewise of uniform figure, as in most *Emydes;* not variable, as in *Testudines;* the neural plates also resemble those of the existing *Emydes*, and particularly of the Box-terrapin (*Cistudo*) in form. The lateral margin of each is bounded by two lines, meeting at an open angle, the anterior line is only one fourth part the length of the posterior one; and this resemblance may be stated with confidence, since the portion of the entosternal piece preserved in the plastron determines the anterior part of the fossil.

The costal plates preserved in the present Chelonite differ from the corresponding ones of the tortoises, and resemble those of the *Emydes* in their regular breadth, and the uniform figure of the extremities articulated with the vertebral pieces; the anterior line of the angular extremity is nearly three times as long as the posterior one.

Further evidence of the relation of the present Chelonite to the fresh-water family is given by the impressions of the epidermal scutes; those covering the vertebral plates (*scuta vertebralia*) agree with those of most *Emydians* in the very slight production of the angle at the middle of their lateral margins, which is bounded by a line running parallel with the axis of the carapace, except where it bends out to form that small angle.

The middle part of each side of the plastron, in the *Emys testudiniformis*, is joined to the carapace by a strong and uninterrupted bony wall, continued from a large proportion of the hyosternal and hyposternal bones upwards to the marginal costal pieces. The median margin of the hyosternals and hyposternals are articulated together by a linear suture, traversing the median line of the plastron, and only broken by a slight angle formed by the right hyposternal, which is a little larger than the left. A similar inequality is not unusual in both tortoises (*Testudinidæ*) and terrapenes (*Emydidæ*). The transverse suture is, of course, broken by the same inequality; that portion which runs between the left hyosternals and hyposternals being two or three lines in advance of the one between the right hyosternals and hyposternals. The posterior half of the broad entosternal piece is articulated to a semicircular emargination at the middle of the hyosternals; so that the whole plastron forms one continuous plate of bone. This is relatively thicker than in existing *Emydes*, resembling in its strength that of tortoises; and it is likewise slightly concave in the middle, which structure is more common in tortoises than in Emydians, save those in which the sternum is moveable; in most of the other species the sternum is flat or slightly convex.

I have shown in my paper on the Turtles of Sheppy,* that the carapace figured by Cuvier† was not sufficiently perfect to decide the affinities of the Chelonian to which it belonged; if the vertebral scutes were less broad and angular than in marine turtles, the neural plates—much less variable in their proportions—were, on the other hand, as narrow as in turtles. But with reference to the plastron of the Sheppy Chelonite, figured by Parkinson,‡ and supposed by Cuvier to belong to an *Emys* of the same species as the carapace above alluded to, I have been able to determine, by an examination of the original specimen in the museum of Professor Bell, that it belonged to the marine genus *Chelone* and to the species *longiceps*. In the fossil *Emys* in Mr. Bowerbank's collection, the plastron being in great part preserved, establishes its nonconformity with the marine turtles, and manifests a striking difference from Parkinson's fossil plastron.

The entosternal piece is impressed, as in Tortoises and Emydes, by the median longitudinal furrow, dividing the two humeral scutes; the transverse linear impression dividing the humeral from the pectoral scutes traverses the hyosternals half an inch behind the suture of the entosternal; the second transverse line, which divides the pectoral from the abdominal scutes, is not so near the first as in tortoises, but bears the same relation to the transverse suture of the plastron as in most Emydes; it does not pass straight across the plastron, but the right half inclines obliquely inward to a more posterior part of the median suture than is touched by the left half. The third transverse line, which divides the abdominal from the femoral scutes, passes straight

* Geological Proceedings, December 1, 1841.

† Ossemens Fossiles, tom. v, part iv, pl. 15, fig. 12.

‡ Organic Remains, vol. iii, pl. 18, fig. 2.

across the plastron between the posterior ends of the bony lateral walls, uniting the carapace and plastron.

	Inches.	Lines.
The breadth of the plastron is	5	10
The outer posterior extent of the lateral wall is . . .	3	9
The breadth of the entosternum	1	5
The depth of the whole bony cuirass at the middle line is .	4	0

In the convexity of the carapace and relative depth of the osseous box, the Sheppy Chelonite slightly surpasses most existing species, resembling in this respect the *Emys ocellata* and *Cistudo Carolina.* The plastron is also slightly concave, as in the male of *Cistudo vulgaris:* it is, however, entire at the line where the transverse joint of the plastron exists in the box-tortoises; and the extent and firm ossification of the lateral supporting walls of the carapace forbid likewise a reference of the fossil to those genera.

The general characters of the present fossil, more especially the uniformity of size and breadth of the preserved vertebral plates and ribs, prove it to be essentially related to the fresh-water or Emydian Tortoises. It exceeded in size, however, almost all known Emydians, and was almost double the dimensions of the Emydian species (*Cistudo Europea*) now inhabiting central Europe. It appears, like the *Cistudines*, to have approached the form of the land tortoises, in the convexity of the carapace, but without possessing that division and hinge of the plastron which peculiarly distinguishes the box-tortoises. The contraction of the anterior aperture of the bony cuirass, especially transversely as compared with the *Platemydians*, would indicate more restricted powers of swimming, and consequently more terrestrial habits. In the thickness and strength of the bones of the buckler, especially of the sternum, we may discern an approach to the genus *Testudo.*

Assuming that the Chelonite here described may be identical with that of which the carapace from Mr. Crow's collection is figured in the 'Ossemens Fossiles,'* the "*Emys de Sheppy*" of Cuvier will be one of the "synonyms" of the present species. Mr. Gray, in his 'Synopsis Reptilium,' 8vo, 1831, has given Latin names to all the fossil reptiles indicated or established by Cuvier, and has called the "*Emys de Sheppy*" "*Emys Parkinsonii*," referring as representations of this species, not to the figure of the carapace above cited, which may belong to the same species as the present *Emys*, but to the figure of the plastron, copied by Cuvier from Parkinson's 'Organic Remains,' and to the figure of the skull in the same work, both of which most unquestionably belong to the genus *Chelone* and not to the genus *Emys.*

The "*Emys Parkinsonii*" of Mr. Gray is a synonym of my *Chelone longiceps.* Cuvier's name,—which, besides the claim of priority, is the result of laborious and direct comparison devoted to the elucidation of its subject,—if rendered into Latin would be *Emys toliapicus;* but as the species to which it refers may not be the one

* Ed. 1824, vol. v, part ii, pl. 15, fig. 12.

here described, and is by no means the only fresh-water tortoise which the clay of Sheppy has yielded; and since the characters of the present species have not hitherto been defined nor its affinities to the land tortoises been pointed out, the interests of science appeared to me to be best consulted by giving a distinct name to the present species.

The fossil here described is from the Eocene clay of Sheppy Island, and forms part of the collection of J. S. Bowerbank, Esq., F.R.S.

Emys lævis. *Bell.* Tab. XXII.

The only specimen I have seen of this species, I obtained from Sheppy a few months since, and it is now in my collection. It has some remarkable peculiarities which distinguish it, at first sight, from every other species of Emydian, either recent or fossil.

The specimen is imperfect at each extremity; the carapace wanting anteriorly the nuchal plate, and posteriorly from the eighth neural plate inclusive. The contour of the carapace is remarkably even, free from all inequalities of surface, and forming, from side to side, nearly a perfect segment of a circle, uninterrupted by either carina or depression of any kind. The whole surface of the bone also is remarkably smooth.

The first neural plate (fig. 1, *s*1) is narrow, being not more than two fifths as broad as it is long; the sides parallel for the first two thirds of its length, then slightly narrowed; its sides are not interrupted by the costal sutures, as the posterior margin of the first costal plate (*pl*1) joins the anterior part of the second neural. The second, third, and fourth neural plates (*s*2—*s*4) are of an elongated hexagonal form, and nearly resemble each other; the fifth, sixth, and seventh (*s*5—*s*7) are also hexagonal, but each shorter than the preceding one; the sixth is narrowed somewhat abruptly, and the seventh still more so, the latter being also shorter than it is broad.

Although the posterior part of the carapace is considerably broken, there appears evidently to be an interval between the seventh and eighth neural plates; at which part the posterior portion of the seventh costal plate and the anterior portion of the eighth approximate to the corresponding plates of the opposite side, on the median line, without the intervention of the neural plates; a peculiarity which I do not remember to have seen in any other of the *Emydidæ*.

The first costal plate occupies in its breadth the whole length of the first neural, and the anterior fifth only of the second; but in consequence of the gradual shortening of the neural plates in the portion of each, posterior to the angle at which the costal sutures join them, the seventh neural receives the costal suture at about the middle of its length.

The marginal plates (fig. 3, *a*, *a*, *a*) are broad, smooth, and curved evenly to the edge, where they turn under at nearly a right angle.

The second and third vertebral scutes ($v2$, 3) are twice as broad as they are long, the outer angles being nearly right angles; and this must be, to a great extent, a permanent character, as the specimen is evidently not young. The fourth vertebral scute ($v4$) is hexagonal, and its breadth is about one fourth greater than its length.

Of the plastron (fig. 2), the whole of the anterior portion is wanting, including the entosternal, the episternals, and a portion of the hyosternals; and the posterior portion has lost the greater part of the xiphisternals. The bones which remain form a broad, somewhat convex, uniform surface.

The most remarkable circumstance connected with this part of the osseous box is the existence of a pair of intercalated, irregularly-formed bones (*hp*), which stand between the marginal portion of the hyosternal (*hs*) and hyposternal bones. These would appear to represent the pair of additional bones which will be seen in *Platemys Bullockii* (Tab. XXI), stretching across between the hyosternals and hyposternals, and, in the latter case, meeting like them in the median line.

I have examined many skeletons of Emydes, but have never observed any similar structure in this genus; but in the genus *Terrapene*, including the ordinary box-tortoises, there appears to be, in some cases, a rudiment of a corresponding bone.*

The total length of the carapace of this specimen, judging from comparison with perfect recent examples of the same genus, was probably rather more than eight inches, and its breadth is six inches.

T. B.

Emys Comptoni. *Bell.* Tab. XX.

The beautiful specimen of fresh-water Chelonia which forms the subject of the present description, is in the collection of the Marquis of Northampton, who has kindly allowed me the use of it, and to whose respected name I have dedicated it.

The general form of this species, as well as many details of its structure, is so similar to that of a typical land tortoise, that it is difficult at first to reconcile its aspect with the idea of its being at all aquatic in its affinities. It is, however, doubtless a true Emys; and although the present specimen is a young one, its characters are sufficiently marked to enable us to distinguish it from every other. The costal plates

* The sternal bones appear liable to occasional curious anomalous variations. Thus, while in *Platemys* there is a perfect pair of intercalated bones between the hyosternals and the hyposternals, and in the present species an approach to a similar interpolation, we find, on the contrary, in *Gymnopus*, a genus of Trionychidæ, the only skeleton of which in this country I have now in my possession, the hyosternals and hyposternals constitute but a single bone on each side, a peculiarity which I believe to be perfectly unique in the whole of the Chelonian order. [T. B.]

had not become ossified to the extremity of the ribs, and there is consequently a space between the costal and marginal plates, interrupted by the free extremities of the ribs, which just reach to the marginal plates. It is the only specimen of the family which I have seen, amongst the fossil Chelonian remains, in which the whole series of neural plates, with the nuchal and pygal, remain without material injury; and the plastron is also nearly entire.

The nuchal plate (fig. 1, *ch*) would form a triangle with its posterior angle obtuse, but that this angle is truncated for its articulation with the first neural (*s*1). This latter plate is quadrate, a little longer than broad, and rather narrowed forwards. The second (*s*2) and third (*s*3) are also quadrate, and nearly equilateral, The fourth (*s*4) is, however, rendered hexagonal by the termination of the costal suture at a short distance from the anterior margin; it is quite as broad as it is long. The fifth neural plate (*s*5) is of a similar form, but notably longer than it is broad, forming a broad hexagon, with the lateral angles nearer the anterior than the posterior margins. The seventh (*s*7) is the only one which forms a nearly symmetrical hexagon, broader than it is long, but with the lateral angles equidistant from the anterior to the posterior margins. The eighth and ninth neural plates (*s*8, 9) are regularly quadrate, the former being broader than it is long, the latter forming a perfect square. It is very remarkable how much more closely the seventh and following neural plates to the tenth are united than any of the anterior ones; indeed the sutures between the seventh and eighth, and between the eighth and ninth, are with difficulty observable, notwithstanding the youth of the individual. The tenth neural (*s*10) and the pygal (*p*) plates are somewhat injured and bent down abruptly by some violence.

I have dwelt somewhat in detail upon the direction of these plates, as their characters evidently bear upon the near relation of this species to the terrestrial type already alluded to.

The internal margin of the first costal plate (*pl*1) exactly coincides with the length of the first neural. The second and fourth costal plates (*pl*2, 4) expand towards the margin of the carapace, and the third and fifth (*pl*3, 5) become narrower in the same direction in a similar degree.

The marginal plates present no important peculiarity in this young specimen.

With regard to the impressions left by the horny scutes, we find that although they are of the ordinary general form, they are less broad and spreading in proportion to their length, than is ordinarily the case in the *Emydidæ*, and particularly in immature age; thus offering another character approaching the terrestrial type.

The plastron (fig. 2) is tolerably perfect, and presents the remarkable expanse which ordinarily characterises the land and fresh-water forms, but especially the former; and the anterior and posterior openings between the carapace and the plastron, for the exit and play of the extremities, are somewhat contracted, and thus appear scarcely to afford sufficient room for the natatorial habits of an aquatic species.

The entosternal plate (*s*) forms an almost regular rhomb; the episternals (*es*) are much broken, and offer no peculiarity in the parts which remain; nor is there, in the general form of the hyosternals (*hs*) or hyposternals (*ps*), or the xiphisternals (*xs*), anything which calls for particular notice.

The contour of the bony case, viewed as a whole, bears out the close relation to the terrestrial form which I have assigned to this species. The slightly curved costal regions of the carapace, and the even flatness of the vertebral portion, as well as the outline of the dorsum, when viewed laterally, show a very striking approximation to the small African species of true Testudo, *T. areolata*, and still more to *T. signata*. But if its geological position did not of itself preclude our considering it as belonging to a terrestrial group, the structure of many parts of its osteology would be sufficient to justify our considering it as a true Emydian.

	Inches.
Length of the carapace	3·2
Breadth of ditto	2·9
Height of the bony case	1·3

T. B.

Emys bicarinata. *Bell.* Tab. XXV and XXVI.

The specimen before me, the only one which I have yet met with of this species, is very large, and, from the close union of the bones, and the nearly obliterated condition of the sutures, is evidently of considerable age; a fact also attested by the forms of the vertebral scutes (*v*2, *v*3, *v*4, T. XXV), which have become greatly narrowed in proportion to their length.

The general outline of the carapace must have been nearly orbicular. The elevation moderate; the part occupied by the vertebral scutes, and about half an inch on each side of them, flattened; and this plain portion bounded on each side by a low obtuse carina, which is itself obscurely and irregularly grooved longitudinally. The sides are considerably sloping, with but a slight curvature.

The carapace is wanting anteriorly in nearly the whole of the nuchal plate, and posteriorly from the tenth neural inclusive. At the sides a few fragments only of the marginal plates exist.

The first neural plate (*s*1) is nearly oval, and, as usual in this family, is wholly included within the first pair of costal plates; it is considerably longer than any of the succeeding ones. The second neural (*s*2) is nearly as broad as it is long, the anterior angles truncated as usual, posteriorly somewhat narrowed; the third neural (*s*3) has the peculiarity of being longer than even the second, and is less narrowed behind; the fourth to the seventh inclusive (*s*4-7) are gradually shorter, the seventh forming a broad hexagon, with the lateral angles (meeting the costal suture) nearly midway between the anterior and posterior margins. The eighth (*s*8) is also broader than it is long, but the lateral angle is near the anterior margin, as in the preceding plates. The ninth ($s9$) is somewhat expanded posteriorly, but less so than usual.

The sixth and seventh of the neural plates are considerably raised towards the centre, but with a slight longitudinal depression along the median line; and there is a considerable triangular or wedge-shaped elevation, commencing with its base near the anterior margin of the eighth, and extending to the posterior margin of the ninth neural plate.

The costal plates ($pl1$—8) differ from those of the species in general in being more regularly parallel at their lateral margins.

The first vertebral scute reaches to the posterior third of the first neural plate ($v1$), and its lateral margins are expanded forwards, but with a slight curve. The second and third ($v2$, 3) have nearly parallel sides, and are both longer than they are broad, the lateral angles being extremely inconsiderable; the fourth ($v4$) is hexagonal, but still with short lateral angles; the fifth ($v5$) has the lateral margins, and, as usual, becomes broader posteriorly.

As the costal or lateral scutes depend, in the only important and variable part of their contour, on the form of the margins of the vertebral, it is unnecessary to describe them.

The plastron (T. XXVI) occupies about its usual relative proportion to the carapace, but it has been so much broken as to afford but little opportunity for any satisfactory or useful description. It would appear, however, from the extent of the openings for the passage of the limbs, that the animal must have possessed considerable powers of swimming, offering in this respect a very marked contrast to the testudiniform character of *E. Comptoni* and *E. testudiniformis*.

	Foot.	Inches.	Lines.
Probable total length of the carapace	1	0	0
Probable total breadth of ditto	0	10	0
Depth of the bony case	0	3	3

T. B.

EMYS DELABECHII. *Bell.* Tab. XXVIII.

An almost gigantic specimen of the fluviatile form of scutate Chelonia, in the collection of the Geological Survey, forms the subject of the present description. It is from the London clay of the Island of Sheppy.

This species far surpasses in size any known Emydian, whether fossil or recent; the carapace having been certainly not less than one foot nine inches in length and one foot five inches in breadth. It very clearly belongs to the form to which I have assigned it, and in some of its broader characters approximates considerably to the last species, *E. bicarinata.* The specimen is, however, unfortunately so badly injured, partly by having been originally much crushed, and partly by recent disintegration, from the decomposition of the pyrites with which it is extensively permeated, that the description must necessarily be confined to little more than general contour.

The osseous case is somewhat less deep, in proportion to its probable length and breadth, than in *E. bicarinata*, as will be seen by a comparison of their dimensions; it is consequently less sloped at the sides, which are also less curved. There is not the slightest indication of a carina, either median or lateral; but the whole vertebral region is simply flattened.

I have already had occasion to observe, that as the scutate Chelonians continue to grow, the vertebral scutes are observed to alter their form, and the relative proportion of their longitudinal and transverse diameters. This takes place particularly by the comparative abbreviation of the angular lateral projections which meet the line of junction of the margins of the corresponding costal scutes. These angles, as the animal grows, and as the scutes increase in size, become comparatively much shorter and more obtuse; and to such an extent does this take place, that in many species the sides of the vertebral scutes become very nearly parallel in old age; as may be observed in the figure of *E. bicarinata* (T. XXV), and in most recent species.

Now the specimen at present under notice, notwithstanding its great size, exhibits this indication of old age, even in a less degree than in the figured specimen of *E. bicarinata*. We could not, therefore, even if other distinctive characters were absent, for a moment confound them as one species.

In longitudinal dimensions the scutes in question ordinarily increase in proportion to the growth of the animal; and afford, in the examination of mutilated fossil Chelonian remains, approximating data for ascertaining the general size of the animal; the second and third vertebral scutes, taken together, being generally rather less than two fifths of the total length of the carapace.

The edge of the present specimen, and the injuries it has undergone, combine to render any satisfactory account of the vertebral series of osseous plates impossible; the nuchal and pygal plates being absent, and the neural wholly indistinguishable; and the plastron has been even more mutilated than the carapace.

The impressions of the vertebral scutes are tolerably perfect, as far as regards the second (*v*2), third (*v*3), and fourth (*v*4). The second and third are about as broad as they are long, irregularly hexagonal, and the lateral angles are but moderately produced; the third has the posterior margin shorter than the anterior; the fourth is rather longer than it is broad, and notably narrowed posteriorly.

The plastron exhibits at least the usual expanse of form which belongs to the typical *Emydes*, but its condition is such as to preclude any detailed description.

	Feet.	Inches.	Lines.
Probable length of the carapace	1	9	0
Probable breadth of ditto	1	5	0
Depth	0	4	8

Such are the meagre details to which we are restricted in describing by far the largest of all the fossil species of this genus. I have the gratification of offering it by name to my distinguished friend Sir Henry De la Bèche, through whose kindness I have the opportunity of including it in the present Monograph.

T. B.

FRAGMENTARY REMAINS OF EMYDIANS.

Emys crassus. Tab. XXVII.

From several such specimens kindly transmitted to me by the Marchioness of Hastings, I have selected for the subjects of Tab. XXVII two portions of a plastron; viz. the hyosternal (figs. 1, 1′) and the hyposternal (figs. 2, 2′). They are chiefly remarkable for their thickness (fig. 3), and also for their size in other dimensions.

The hyosternal shows on its outer surface (fig. 1) very strong impressions of the interspace or union between the humeral and pectoral scutes, and between the pectoral and abdominal scutes. The hyposternal shows the same kind of impression between the abdominal and femoral scutes.

These specimens were discovered in the Eocene sand at Hordwell, and are in the museum of the Marchioness of Hastings.

In Tab. XXIV, figs. 1—5, are figured some portions of the carapace of an *Emys*, from the Eocene deposits on the north shore of the Isle of Wight. These also form part of the collection of the Marchioness of Hastings.

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TAB. I.

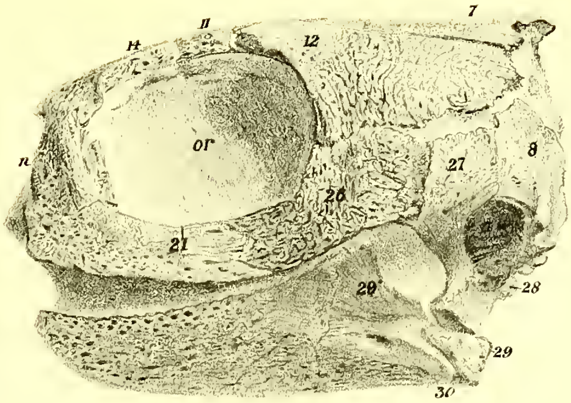
Skull of *Chelone breviceps*, nat. size.

Fig.
1. Side view.
2. Top view.
3. Base view.
4. Back view.

The following numerals indicate the same bones in each figure.

1. Basioccipital.
2. Exoccipital.
3. Supraoccipital.
4. Paroccipital.
5. Basisphenoid.
7. Parietal.
8. Mastoid.
11. Frontal.
12. Postfrontal.
14. Prefrontal (with connate Nasal and Lachrymal).
21. Maxillary.
26. Malar.
27. Squamosal.
28. Tympanic.
29. Articular.
29. Surangular.
30. Angular.
32. Dentary.

1



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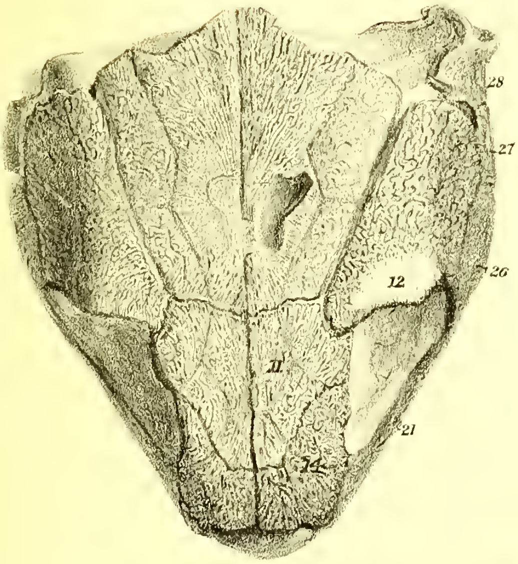

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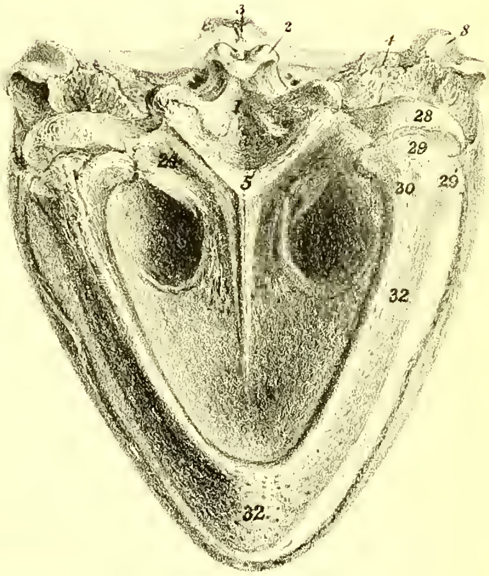

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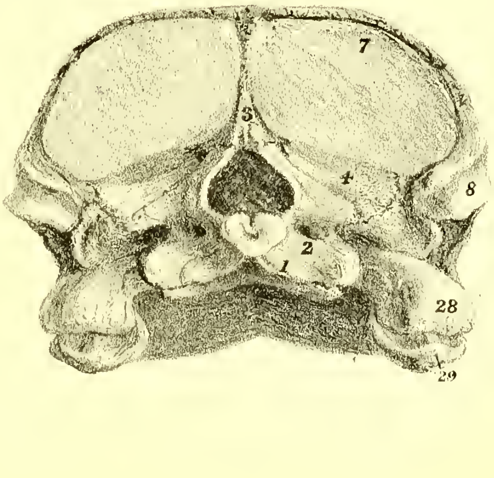

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Dunkel del. et lith.

TAB. II.

Chelone breviceps, four fifths of the natural size.

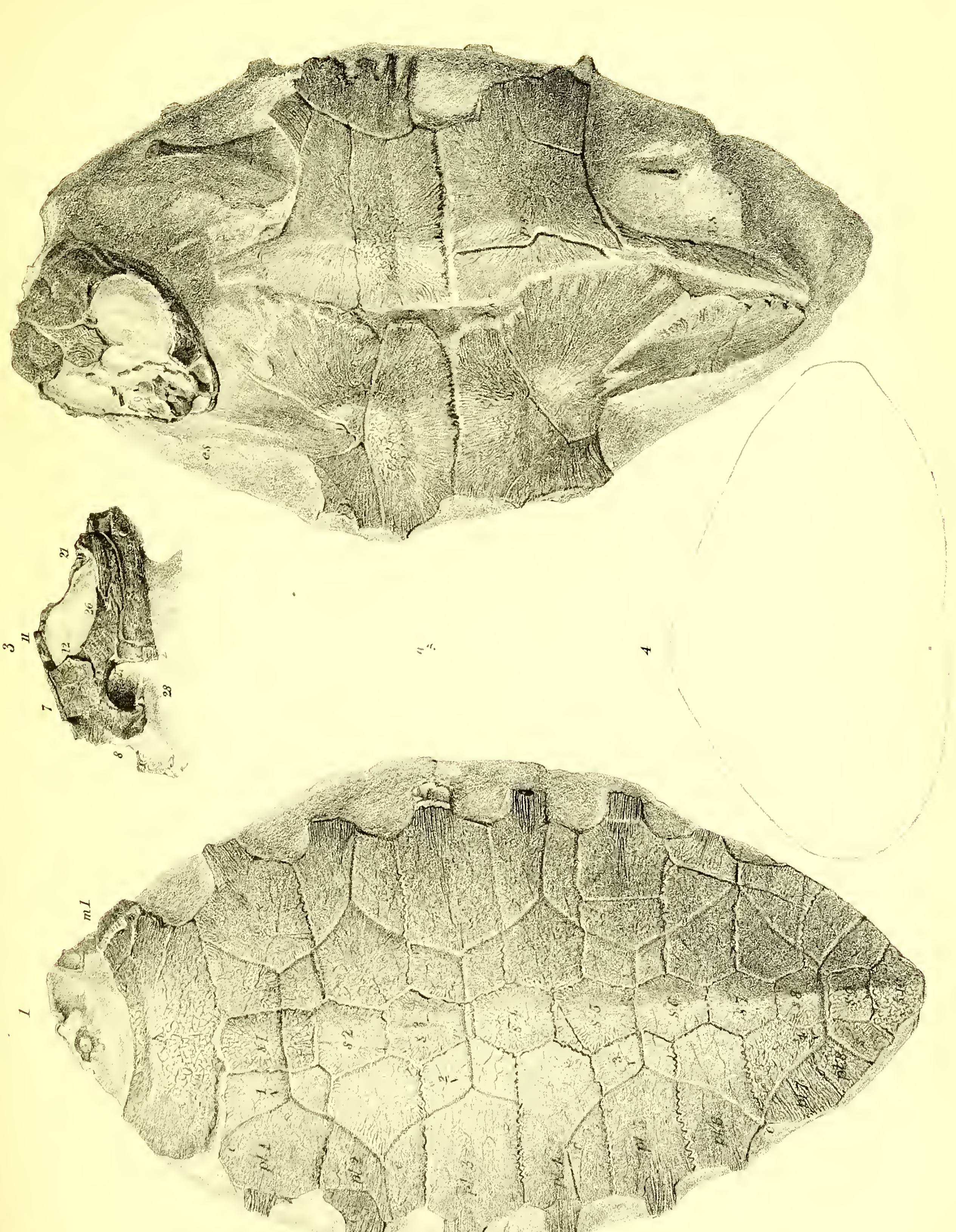
Fig.

1. Upper view of the carapace.
   - *ch.* The nuchal plate.
   - *s*1—*s*10. The neural plates, most of which are connate with the neural spines.
   - *pl*1—*pl*8. The costal plates, connate with the pleurapophyses or vertebral ribs.
   - *v*1—*v*4. Impressions of the vertebral scutes.
   - *m*1. The first marginal plate.

2. Under view of the plastron and bent-down skull.
   - *es.* Episternal element of plastron.
   - *hh.* Hyosternals.
   - *ps.* Hyposternals.
   - *xs.* Xiphisternals.

3. Side view of skull.
   - 7. Parietal.
   - 8. Mastoid.
   - 11. Frontal.
   - 12. Postfrontal.
   - 21. Maxillary.
   - 26. Malar.
   - 27. Squamosal.
   - 28. Tympanic.

4. Outline of the transverse section of the middle of the thoracic-abdominal case.



Dinkel del. et lith.

Day & Son lith.rs to the Queen

TAB. III.

Skull of *Chelone longiceps*, nat. size.

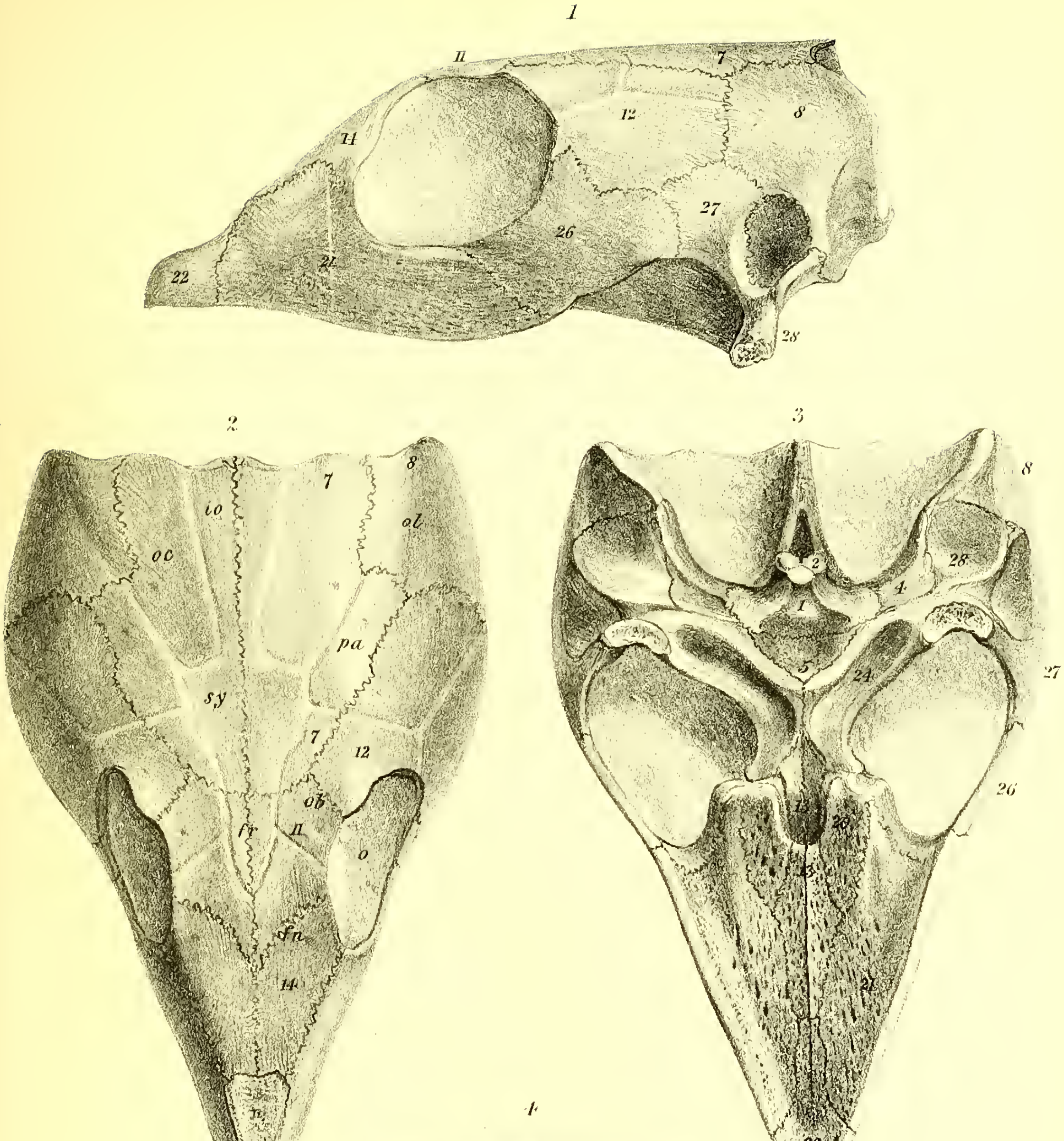
Fig.
1. Side view.
2. Top view.
3. Base view.
4. Back view.

The same numerals indicate the same bones as in Tab. I.

13, 13. Vomer.
20. Palatine.
22. Premaxillary.
24. Pterygoid.

The following perishable parts are indicated by the impressions left on the bone:

fr. The frontal scute.
sy. The sincipital scute.
io. The inter-occipital scute.
oc. The occipital scute.
ol. The occipito-lateral scute.
pa. The parietal scute.
ob. The supraorbital scute.
fn. The frontonasal scute.



Schar f. del. Dinkel lith.

Day & Son lith.rs to the Queen

TAB. IV.

Chelone longiceps, nat. size.

Fig.

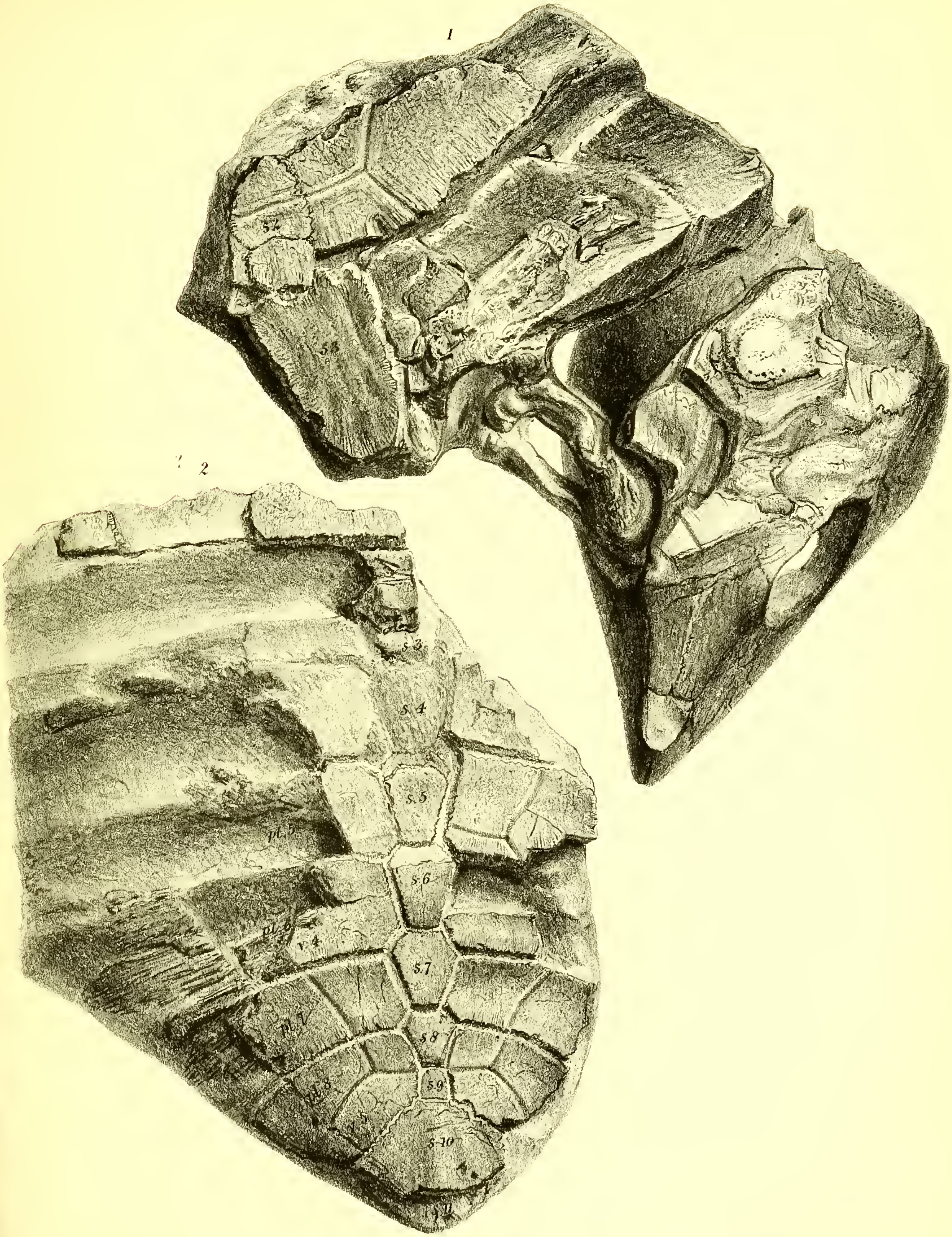
1. Skull and portion of carapace.
   *s*2. Second neural plate.
   *s*3. Third neural plate.

2. Portion of carapace.
   *s*4—*s*11. Fourth to eleventh neural plates.
   *pl*5—*pl*8. Impressions or remains of costal plates.
   *v*4—*v*5. Impressions of fourth and fifth vertebral scutes.

T. IV.

1

2



...nkel del. et lith.

Day & Son lith[rs] to the Queen.

TAB. V.

Chelone longiceps.

Fig.

1. Upper view of the carapace, two thirds of the natural size.
   - *ch.* Nuchal plates.
   - *s*1—*s*10. Neural plates.
   - *pl*1—*pl*8. Costal plates.
   - *v*1—*v*4. Vertebral scutes.

2. Under view of the plastron of another specimen, two thirds nat. size.
   - *s.* Entosternal.
   - *es.* Episternals.
   - *hs.* Hyosternals.
   - *ps.* Hyposternals.
   - *xs.* Xiphisternals.
   - 63. The ischium.

²/3 Nat. size.

TAB. VI.

Chelone latiscutata, nat. size.

Fig.

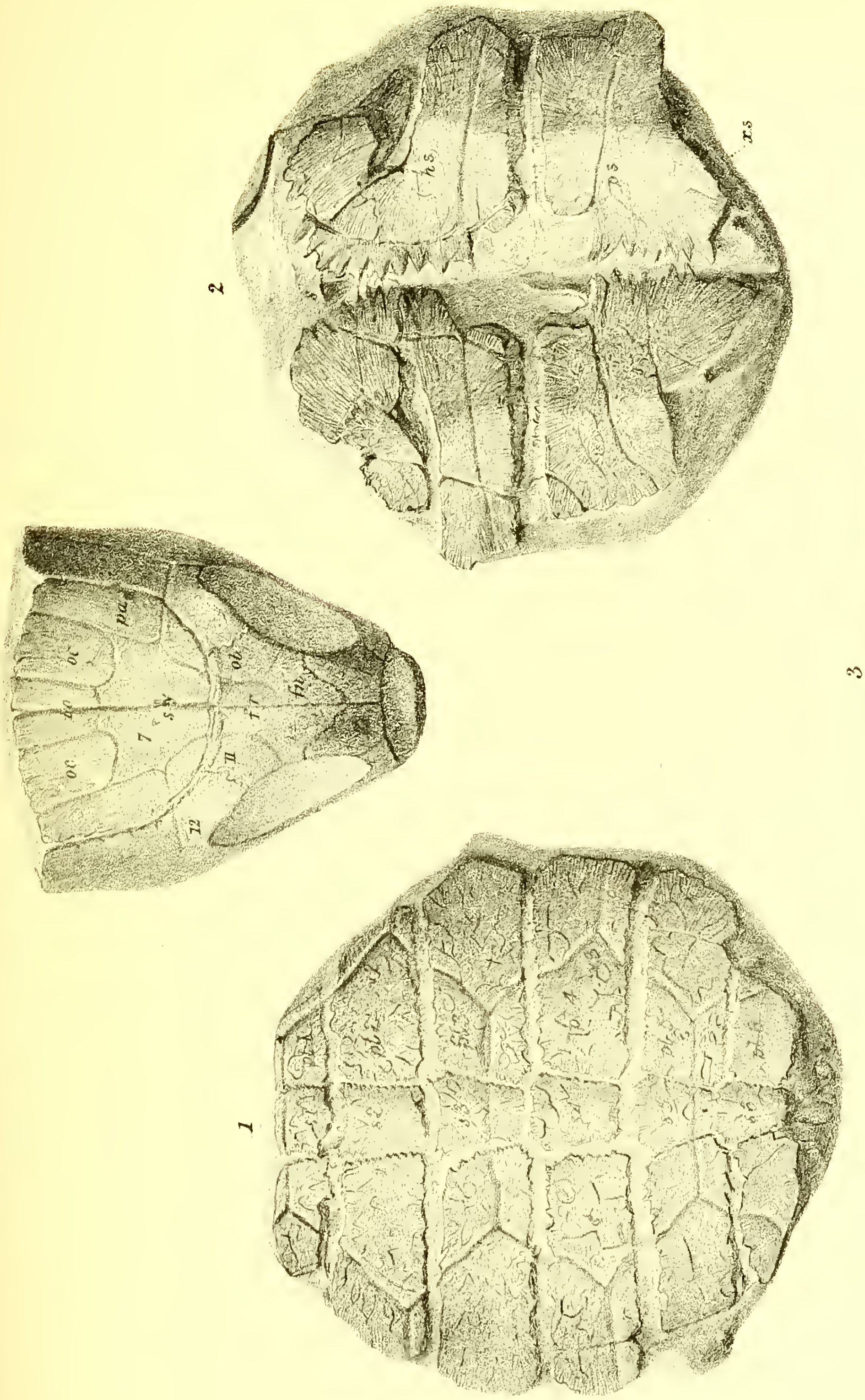
1. Upper surface of the carapace.

*s*1. First neural plate.	*pl*1. First costal plate.
*s*2. Second do.	*pl*2. Second do.
*s*3. Third do.	*pl*3. Third do.
*s*4. Fourth do.	*pl*4. Fourth do.
*s*5. Fifth do.	*pl*5. Fifth do.
*s*6. Sixth do.	*pl*6. Sixth do.

*v*2. The impression of the second vertebral scute.
*v*3. The impression of the third vertebral scute.

2. Lower surface of the plastron.
   s. Extremity of the entosternal.
   hs. The hyosternal.
   ps. The hyposternal.
   xs. Impressions of the xiphisternals.

3. Anterior surface of the carapace and plastron, showing the degree of convexity of those parts, and the depth of the osseous case.
   51 is the scapular arch.



TAB VII.

Chelone convexa.

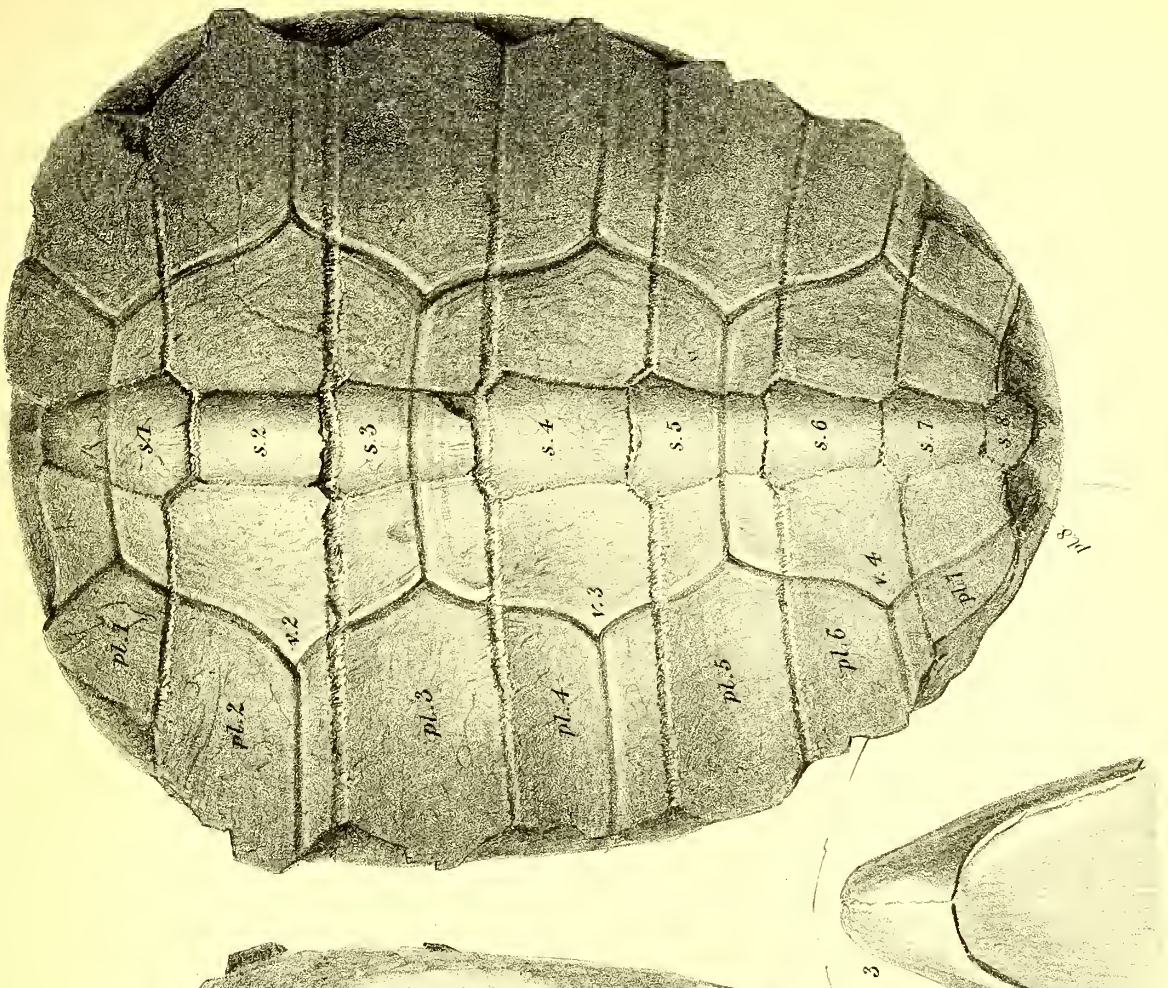
Fig.

1. Upper view of the carapace, nat. size.

2. Under view of the plastron, nat. size.
The letters and figures indicate the same parts as in the previous subjects.
53. The humerus. 64. The pubis. 65. The femur.

3. Under view of the symphysis and part of the rami of the lower jaw.

4. Outline of the curve of the carapace.



Dinkel del et lith.   Day & Son lith to the Queen

TAB. VIII.

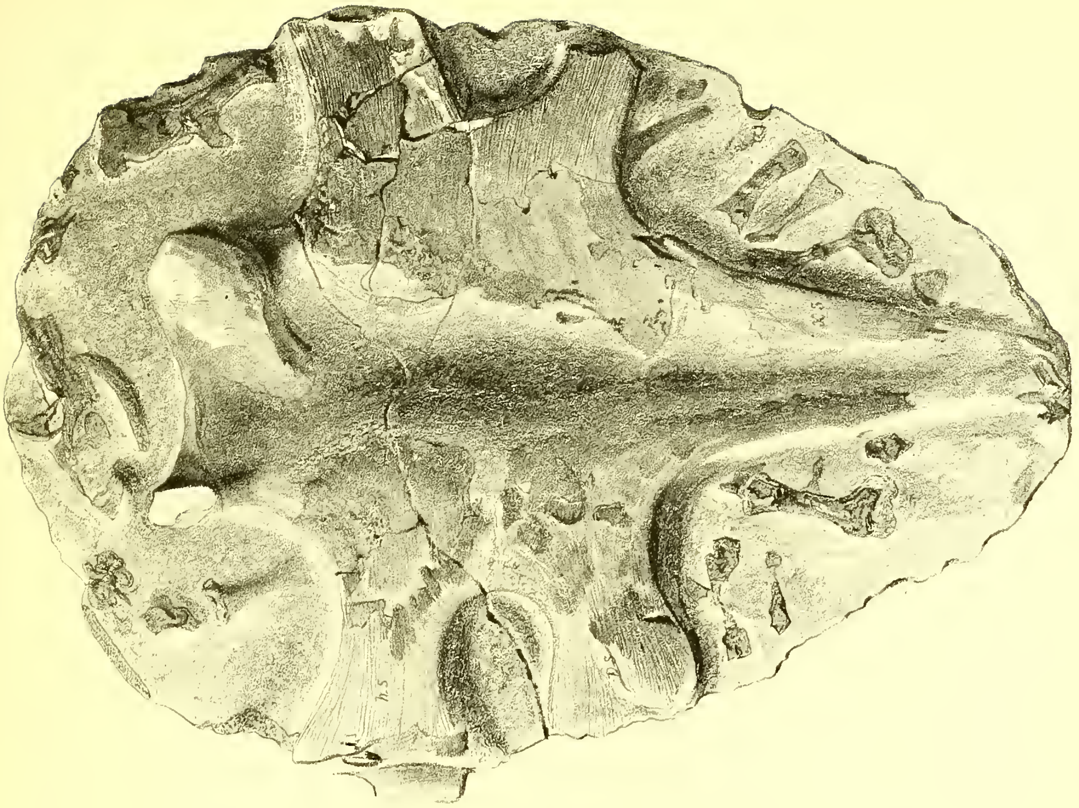
Chelone subcristata.

Fig.

1. Upper view of the carapace, three fifths of the natural size.

2. Under view of the plastron of the same specimen.

The letters and figures indicate the same parts as in the preceding subjects.



TAB. VIII*A*.

Chelone subcarinata.

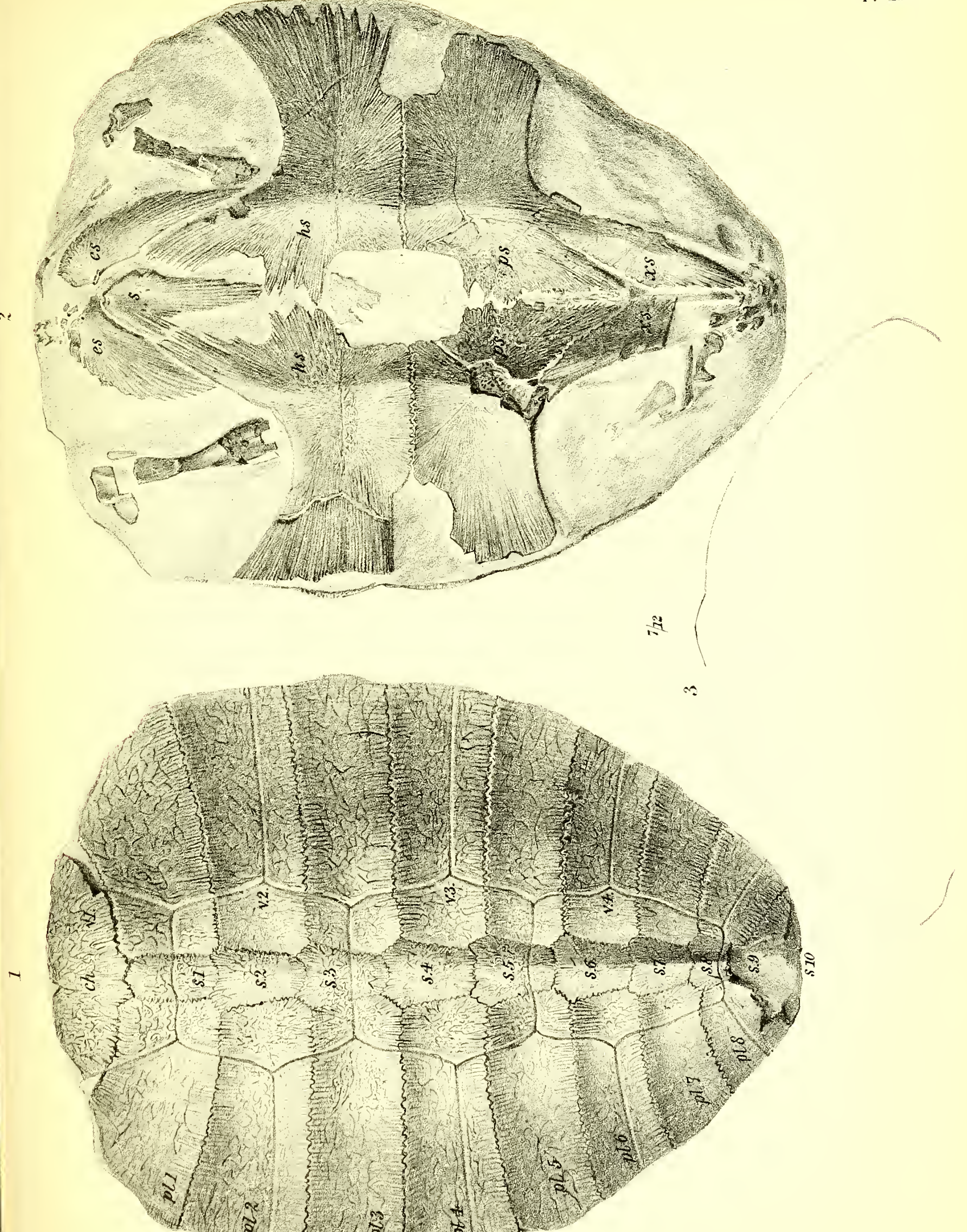
Fig.

1. Upper view of the carapace, seven twelfths of the natural size.

2. Under view of the plastron of the same specimen.

3. Outline of the transverse contour of the carapace.

T. VIII. A.



1
2
3
ch.
v.1
v.2
v.3
v.4
s.1
s.2
s.3
s.4
s.5
s.6
s.7
s.8
s.9
s.10
pl.1
pl.2
pl.3
pl.4
pl.5
pl.6
pl.7
pl.8
es
hs
ps
xs
1/2

TAB. IX.

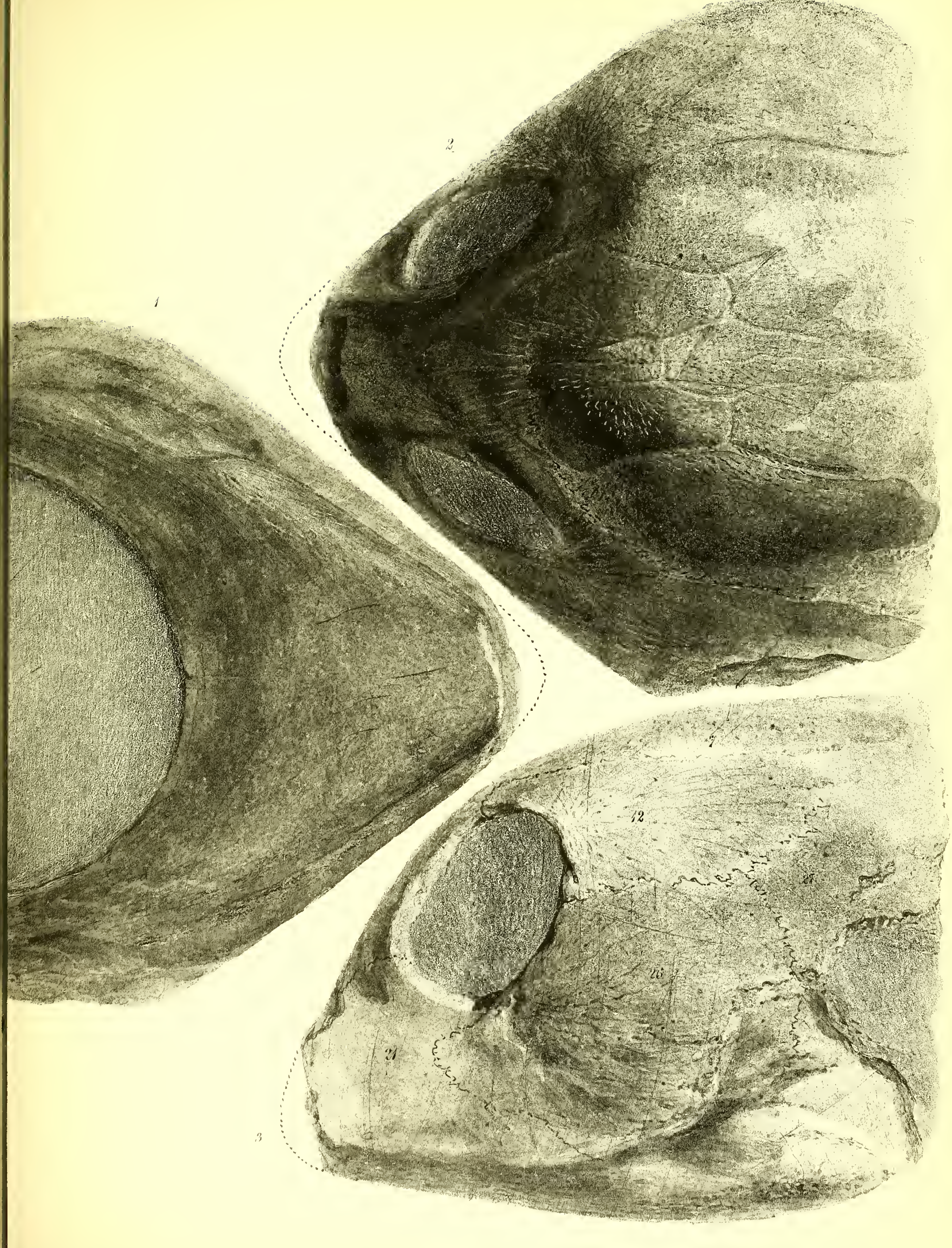
Skull of *Chelone planimentum,* nat. size.

Fig.

1. Under view of the lower jaw, showing the characteristic extent and flatness of the symphysis.

2. Upper view of the skull.

3. Side view of the skull.


1
2
3
7
12
21
26

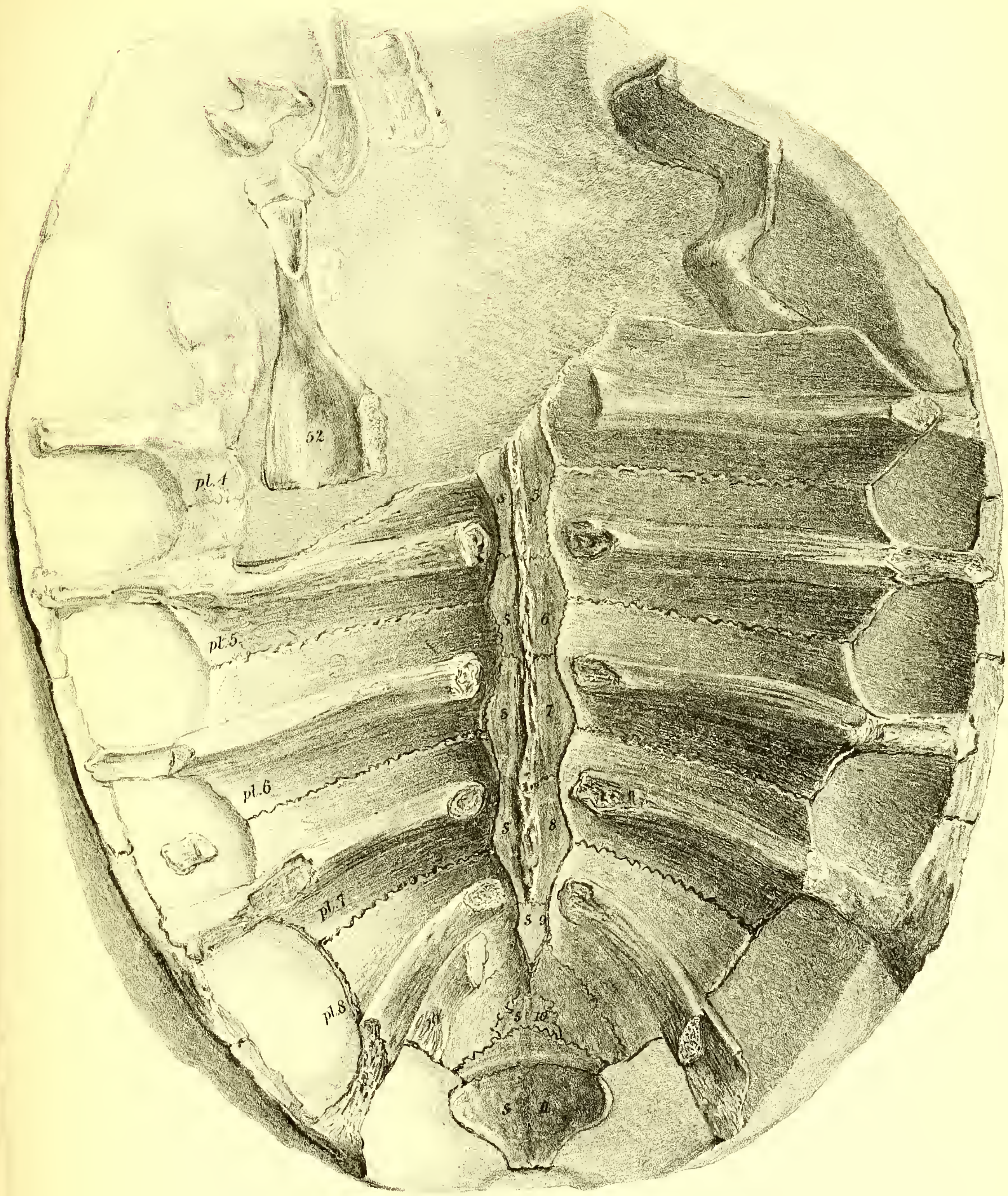
TAB. X.

Chelone planimentum.

Under or inside view of the carapace, half the natural size.

*s*5—*s*8. The fifth to the eighth neural plates which are anchylosed to the neural spines.

*s*9—*s*11. Three succeeding neural plates which do not become so anchylosed.



Scharf del. Dinkel lith.

Day & Son, lith^rs to the Queen

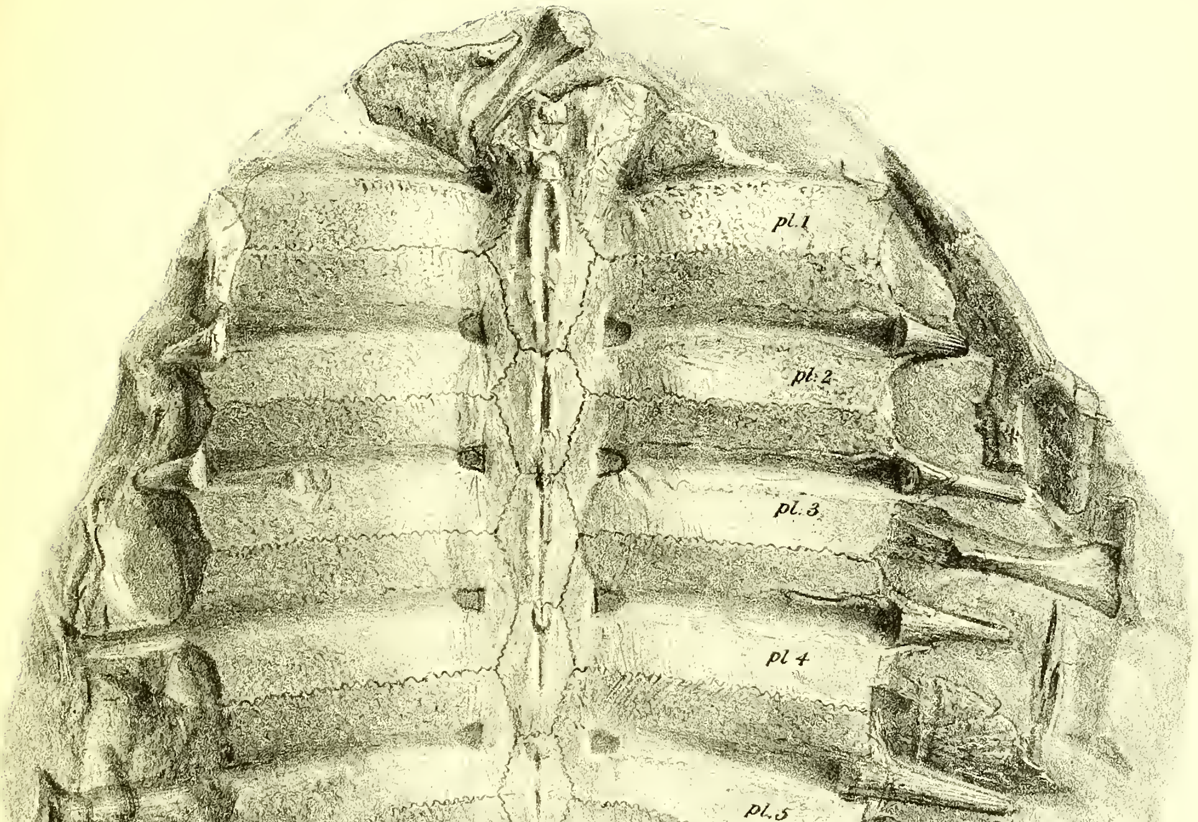
TAB. X*A*.

Chelone planimentum.

View of a cast of the under or inner surface of the carapace; with portions of the ribs and marginal plates: one third the natural size.

*pl*1—*pl*8. Impressions of the costal plates and ribs.

*m*11, *m*12. The eleventh and twelfth marginal plates.



Nat. Si.

TAB. XI.

Skull of the *Chelone crassicostata*, two thirds of the nat. size.

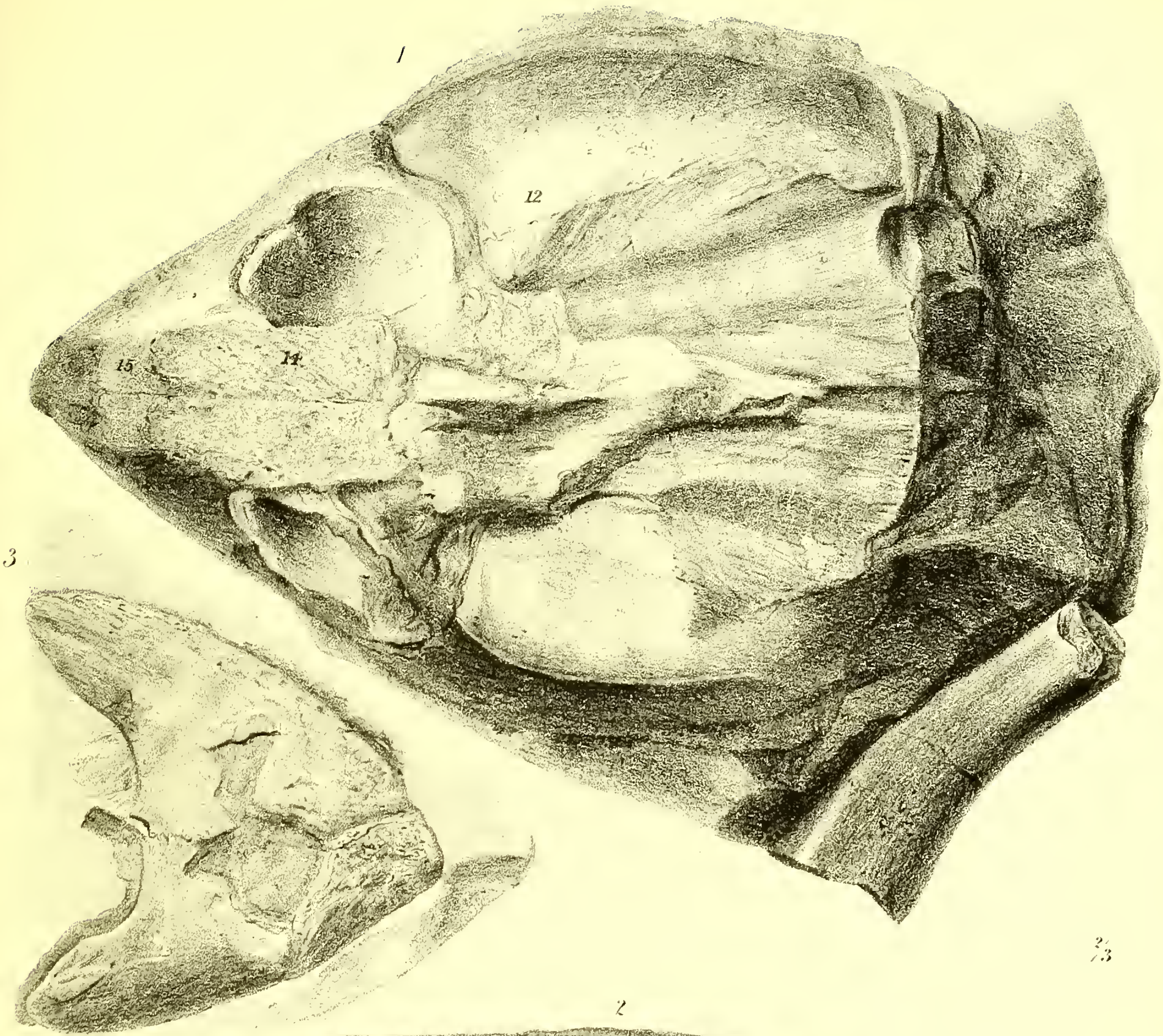
Fig.

1. Upper view, showing chiefly a cast of the under surface of the bones.
   12. The situation of the postfrontals. 14. The prefrontals. 15. The nasals.

2. Side view.

3. Under view of the symphysis menti.

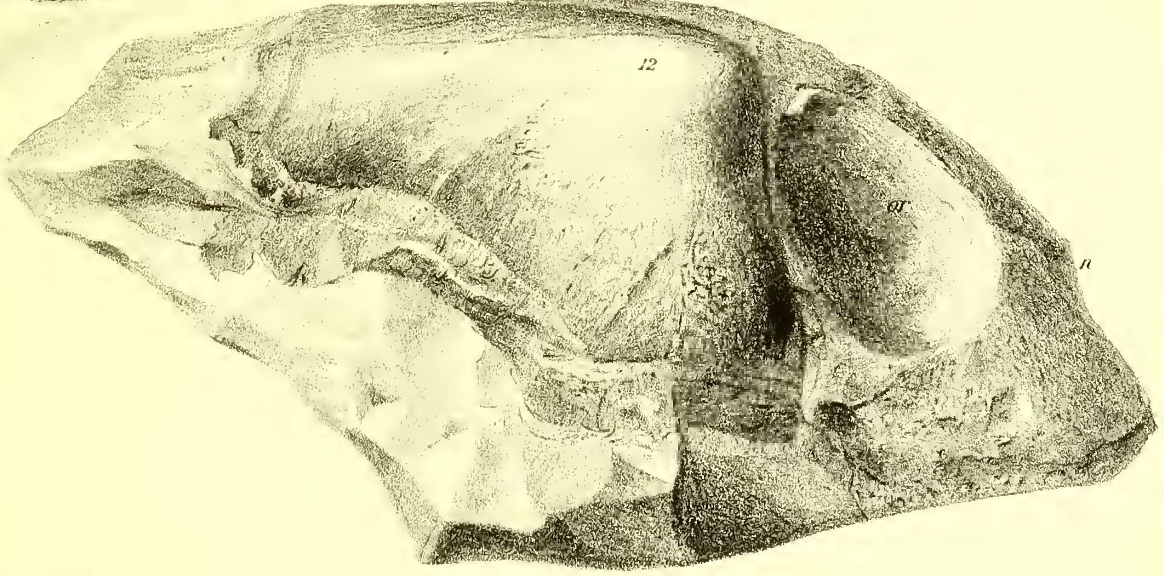
1



3

2/3

2



Dinkel del et lith

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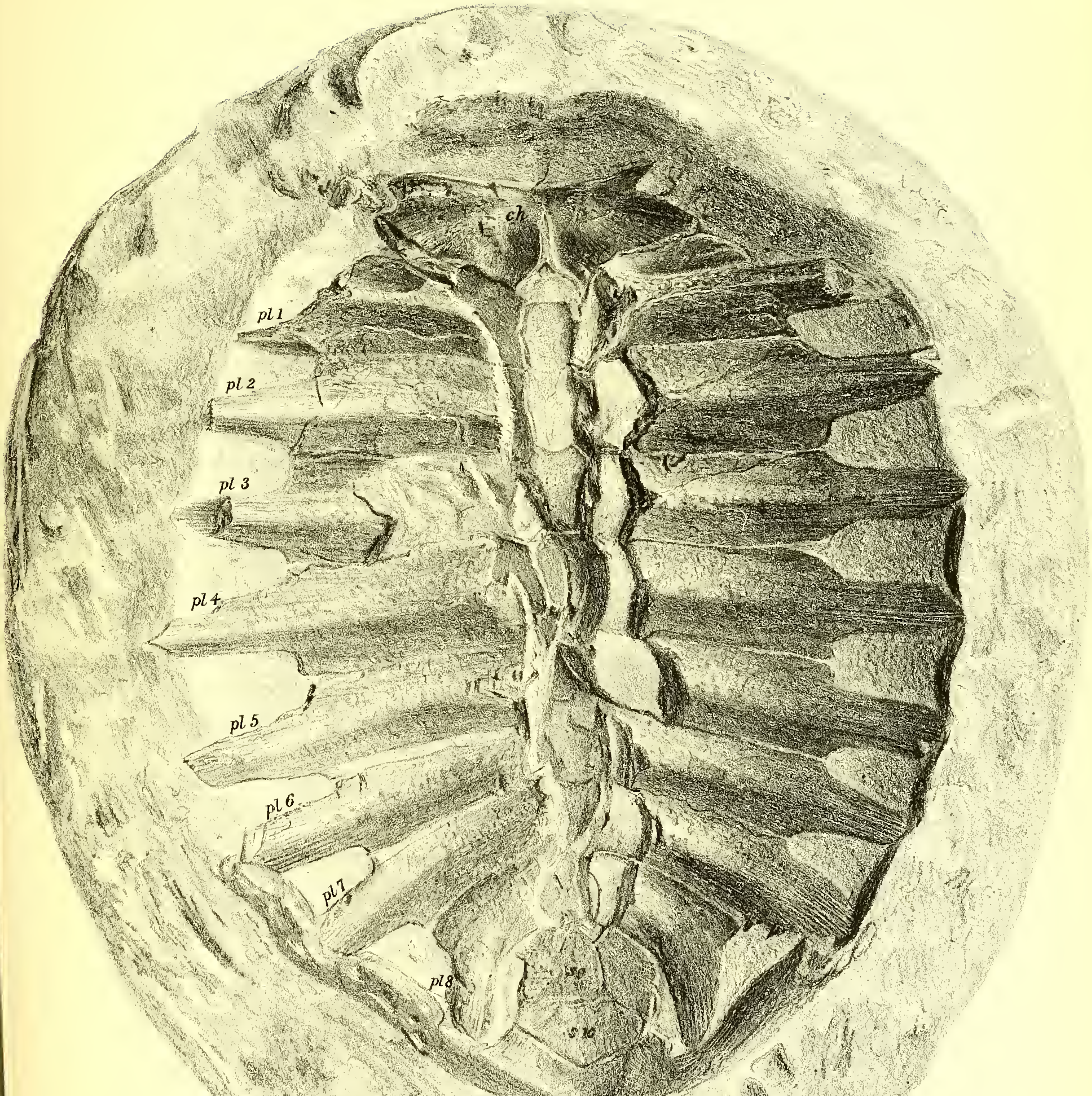
TAB. XII.

Chelone crassicostata.

View of the inner surface of the carapace, half the natural size.

ch. The nuchal plate.
*pl*1. The first costal plate and adherent rib.
*pl*2. The second ditto.
*pl*3. The third ditto.
*pl*4. The fourth ditto.
*pl*5. The fifth ditto.
*pl*6. The sixth ditto.
*pl*7. The seventh ditto.
*pl*8. The eighth ditto. The figures are placed above the free projecting ends of the ribs; they belong to the second and the ninth dorsal vertebræ inclusive.
*s*9. The ninth neural plate.
*s*10. The tenth neural plate.
py. The last neural or the "pygal" plate.

These are developed, like the nuchal plate, in the substance of the derm, and do not become confluent with any parts of the endoskeleton.



Dunkel del. et lith.

Day & Son lith^rs to the Queen

TAB. XIII.

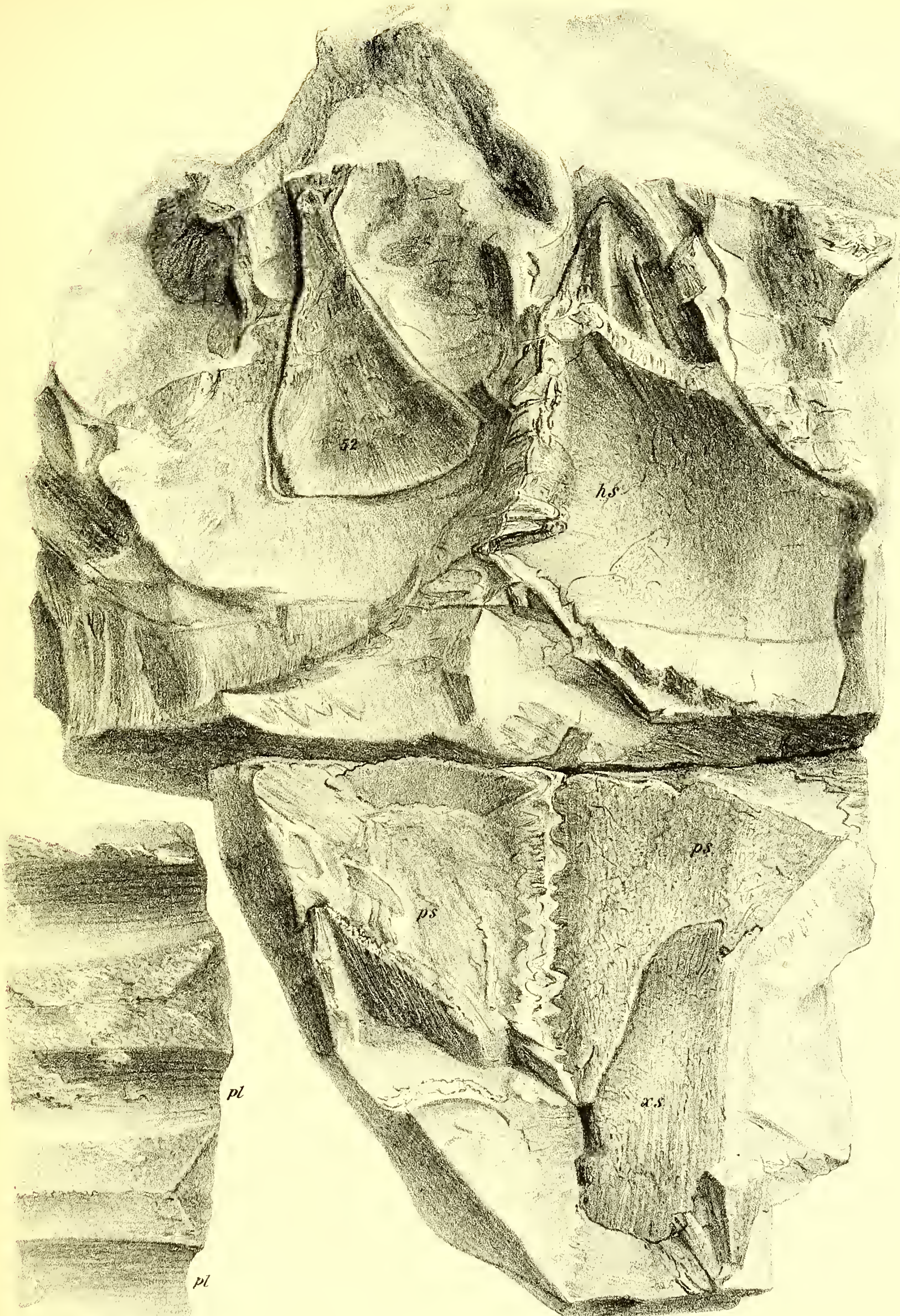
Chelone crassicostata.

Fig.

1. Portion of the plastron seen from the under side.

   hs. The hyosternal; *ps,* the hyposternal; *xs,* the xiphisternal. 52 is the coracoid, exposed by the removal of the right hyosternal.

2. Cast in the matrix of a portion of the carapace of the same individual, showing the characteristic thickness of the ribs, *pl, pl.*



Dinkel del. et lith.

Day & Son lith^rs to the Queen

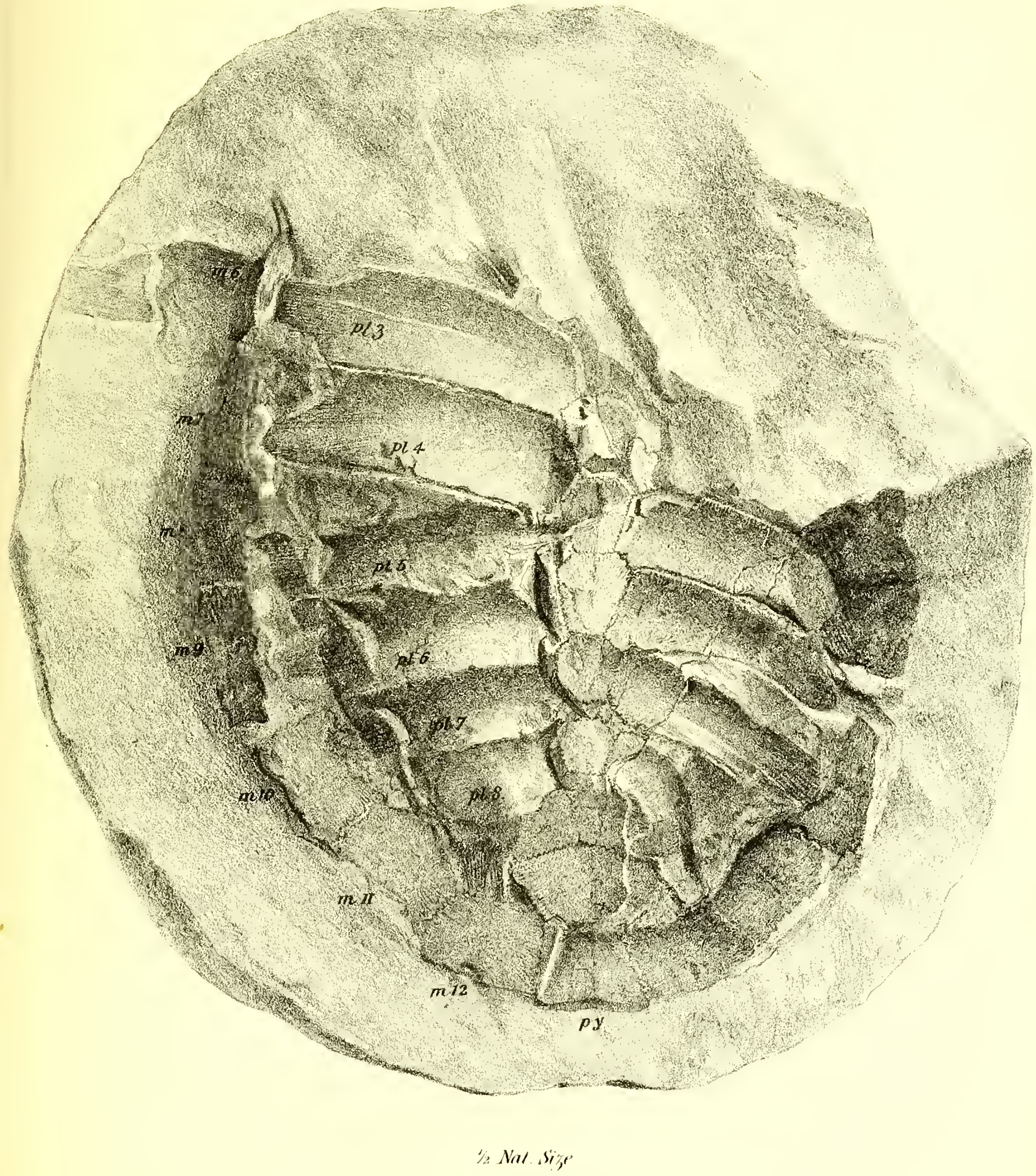
TAB. XIII*A*.

Chelone crassicostata.

Portion of the carapace, half the nat. size, with the corresponding series of marginal plates, *m*6—*m*12, and *py*.

*pl*3 and *pl*4, the third and fourth costal plates of the left side; *pl*5—*pl*8, impressions in the matrix of the succeeding costal plates.

T. XIII A.



½ Nat. Size

Dinkel del. et lith.

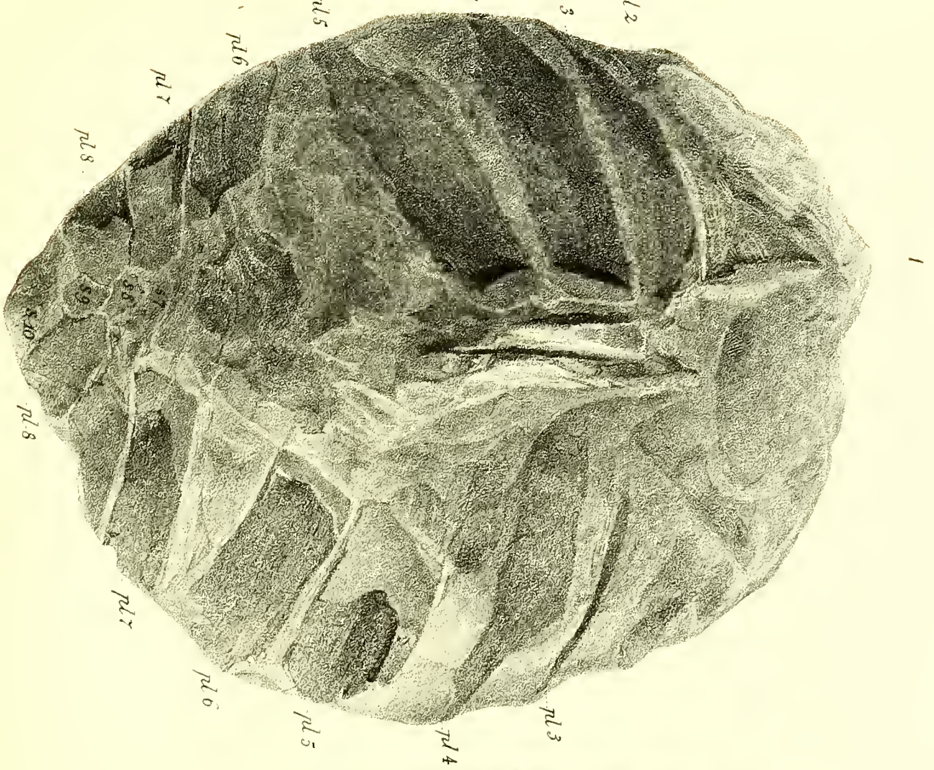
TAB. XIII*B*.

Chelone crassicostata, half the nat. size.

Fig.

1. Outside view of the carapace. *s7—s10*, the seventh to the tenth neural plates inclusive: *pl2—pl8*, the second to the eighth costal plates of the left side; *pl3—pl8*, the third to the eighth, inclusive of the right side.

2. The plastron dislocated and crushed in, with part of the skull showing the orbit *o*; *hs*, the hyosternal; *ps*, the hyposternal; *xs*, the xiphisternal; 51, the scapula; 52, the coracoid.



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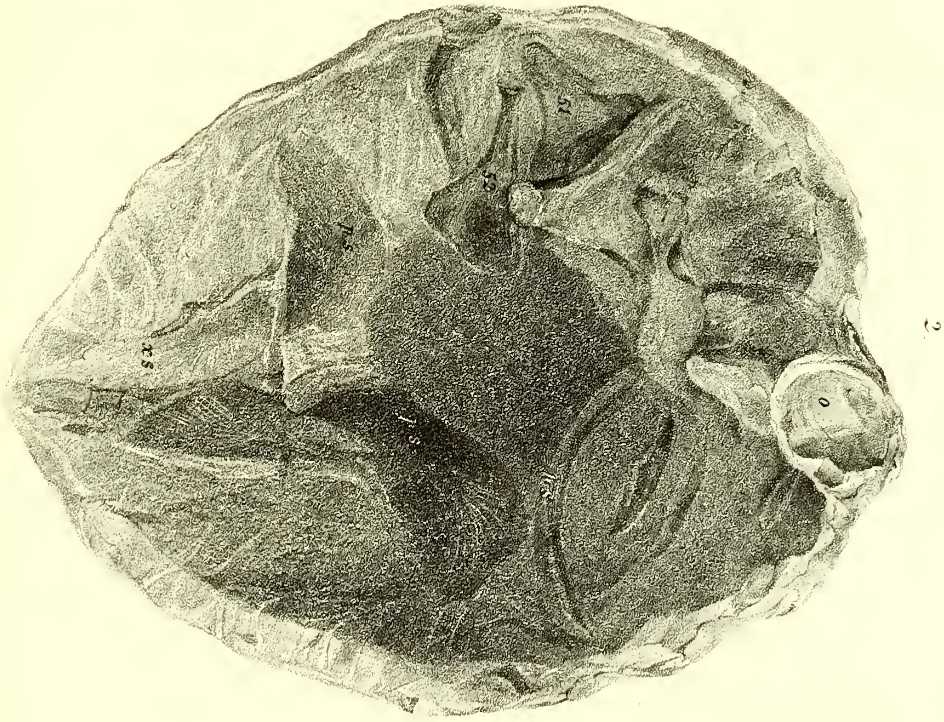


2.

From Nature & on Stone by J. Erxleben.

TAB. XIV.

Chelone declivis.

Fig.

1. Upper view of the left moiety of the carapace, nat. size.

ch. Impression of the nuchal plate.

*s*1. First neural plate.
*s*2. Second ditto.
*s*3. Third ditto.
*s*4. Fourth ditto.
*s*5. Fifth ditto.
*s*6. Sixth ditto.
*s*7. Seventh ditto.

*pl*1. First costal plate.
*pl*2. Second ditto.
*pl*3. Third ditto.
*pl*4. Fourth ditto.
*pl*5. Fifth ditto.
*pl*6. Sixth ditto.
*pl*7. Seventh ditto.

*v*1. Impression of the first vertebral scute.
*v*2. Impression of the second vertebral scute.
*v*3. Impression of the third vertebral scute.
*v*4. Impression of the fourth vertebral scute.

2. View of part of the dislocated right half of the carapace. The same letters and numerals signify the same parts.

5. Outline of the natural transverse curve of the carapace.

Dinkel del. et lith.

Day & Son, Lithrs to the Queen

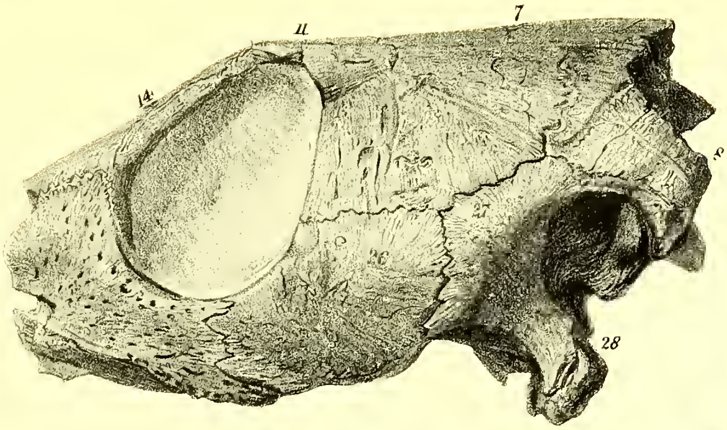
TAB. XV.

Skull of *Chelone cuneiceps*, nat. size.

Fig.
1. Side view.
2. Top view.
3. Base view.
4. Back view.

The letters and numerals indicate the same parts as in Tabs. I and III.

1



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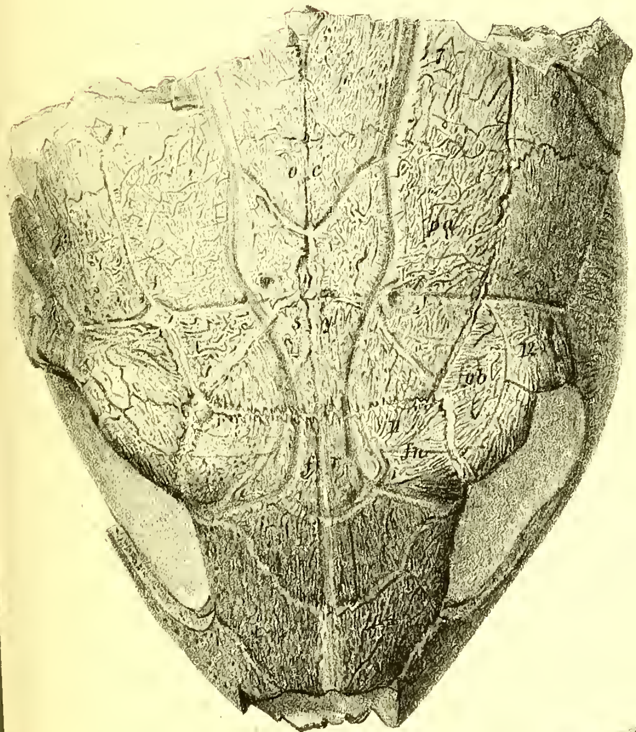

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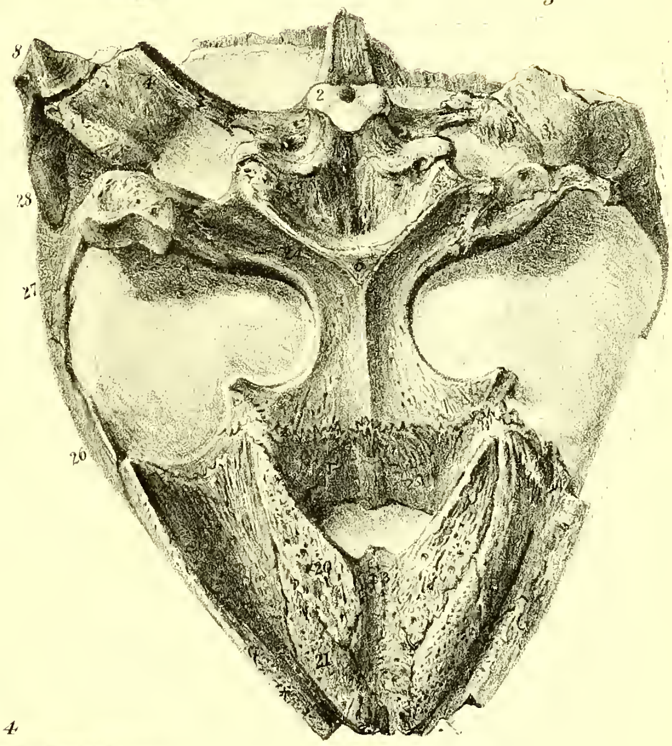

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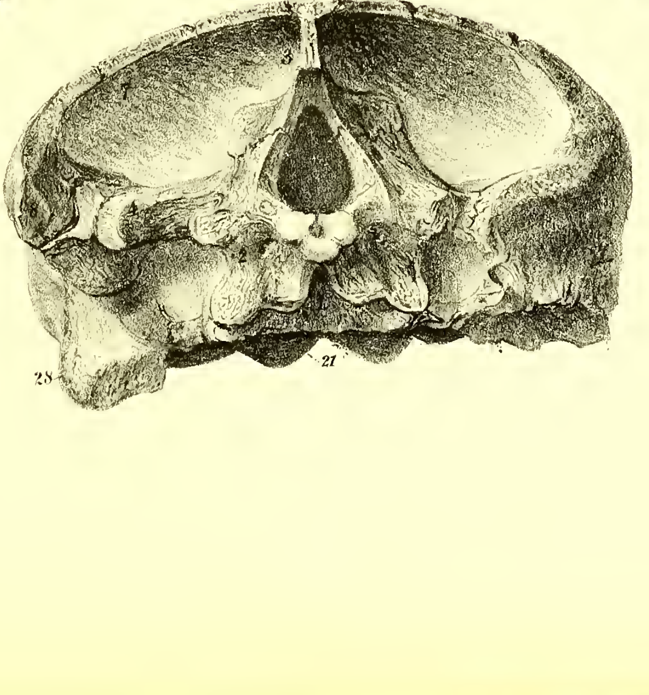


Dinkel del et lith.

Day & Son, Lith^rs to the Queen

TAB. XVI.

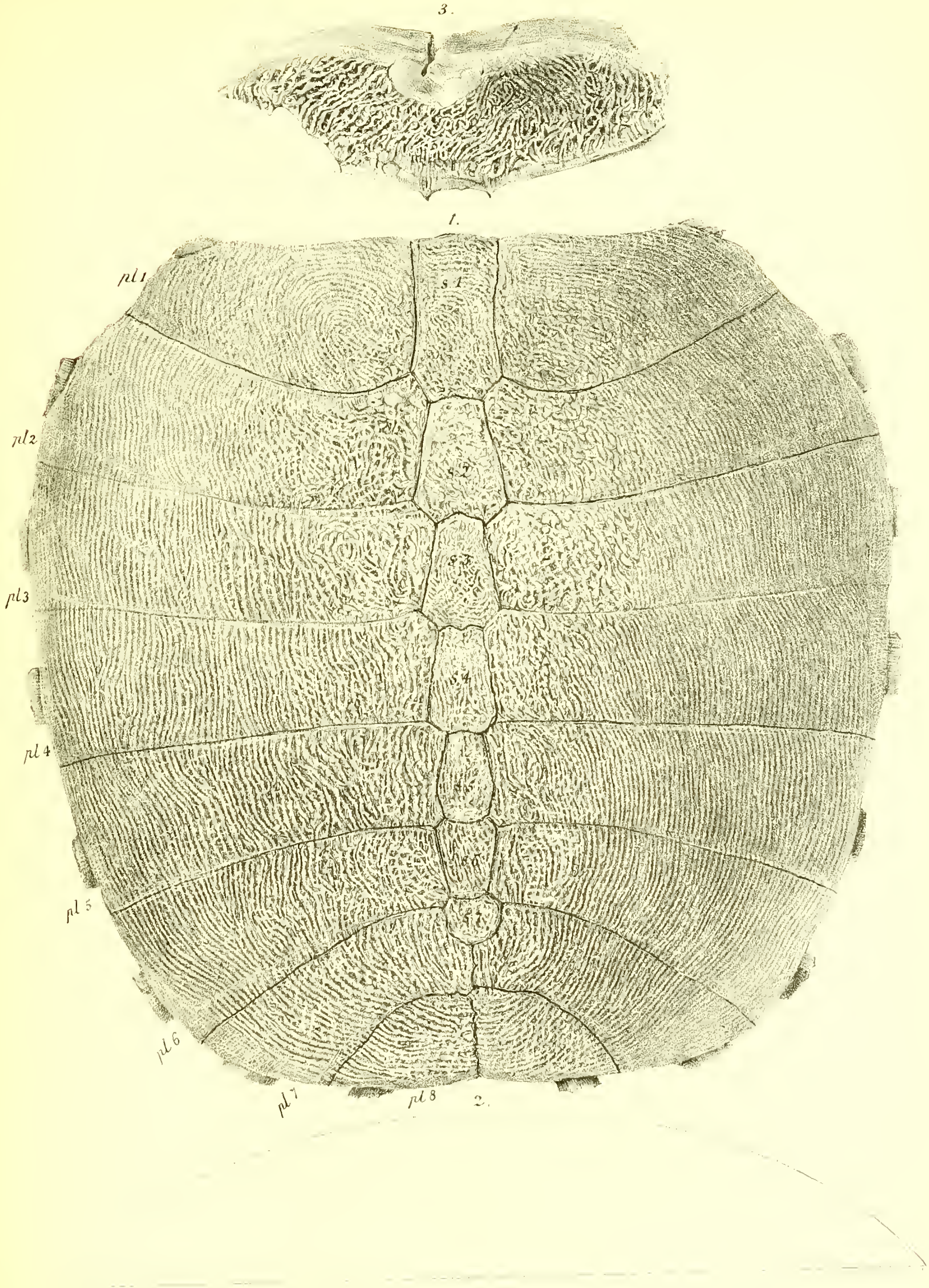
Trionyx Henrici.

Fig.

1. Upper view of the carapace, wanting the nuchal plate, half nat. size.
   *s*1—*s*7. The first to the seventh neural plates inclusive.
   *pl*1—*pl*8. The eight costal plates of the left side.

2. Outline of the transverse curvature of the upper surface of the carapace.

3. The nuchal plate of probably the same species of *Trionyx;* but of another individual : half the natural size.



Engraved by Erxleben

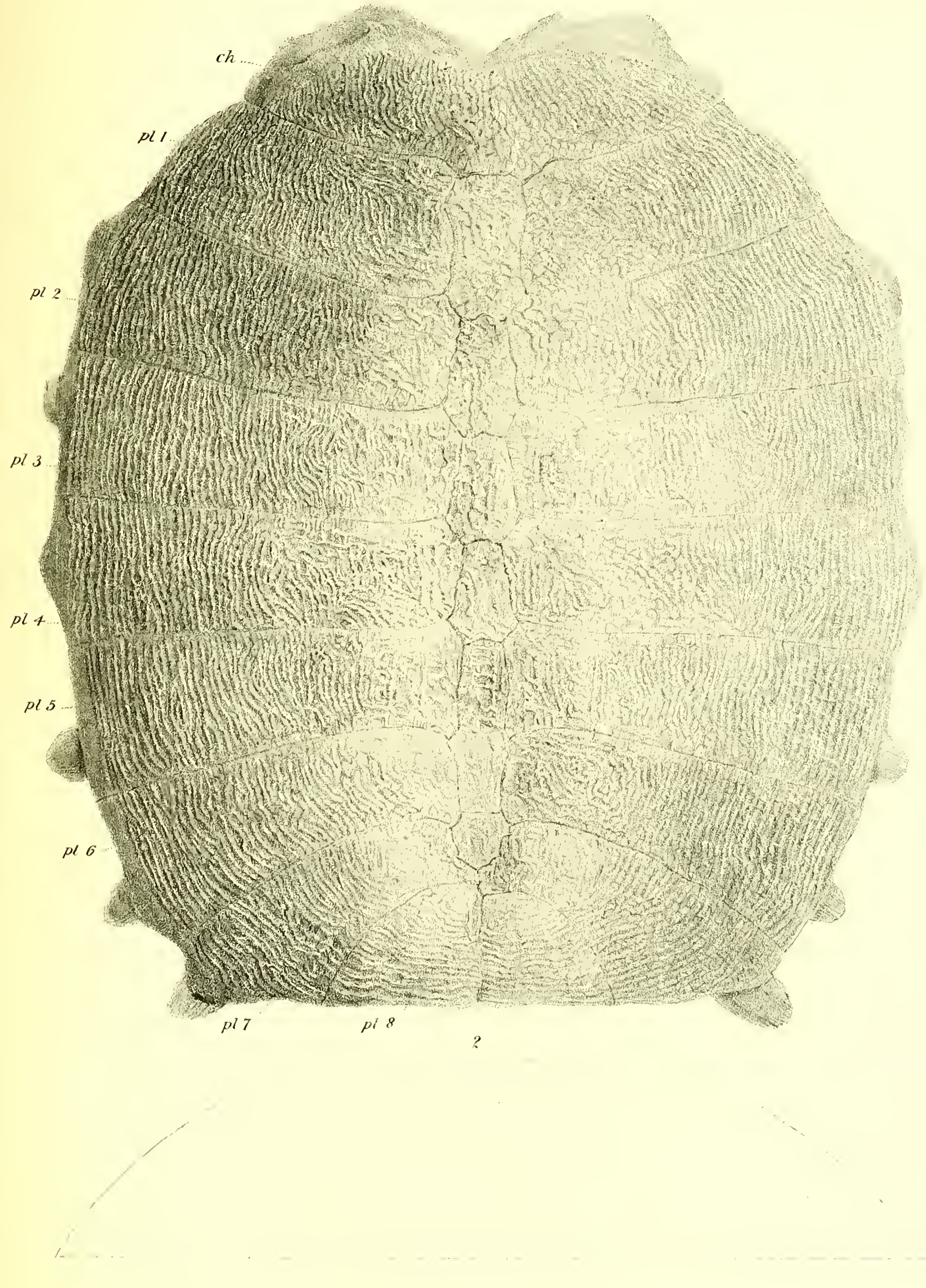
TAB. XVI*A*.

The carapace of the *Trionyx Barbaræ*, half nat. size.

a, Shows the longitudinal contour of the middle of the upper surface, and fig. 2, the transverse curvature of the carapace.

a

1



2

Stone by J. Erxleben

Day & Son lith^rs to the Queen

TAB. XVII.

Trionyx incrassatus.

Fig.

1. Inside view of the carapace, wanting the nuchal plate, half nat. size.

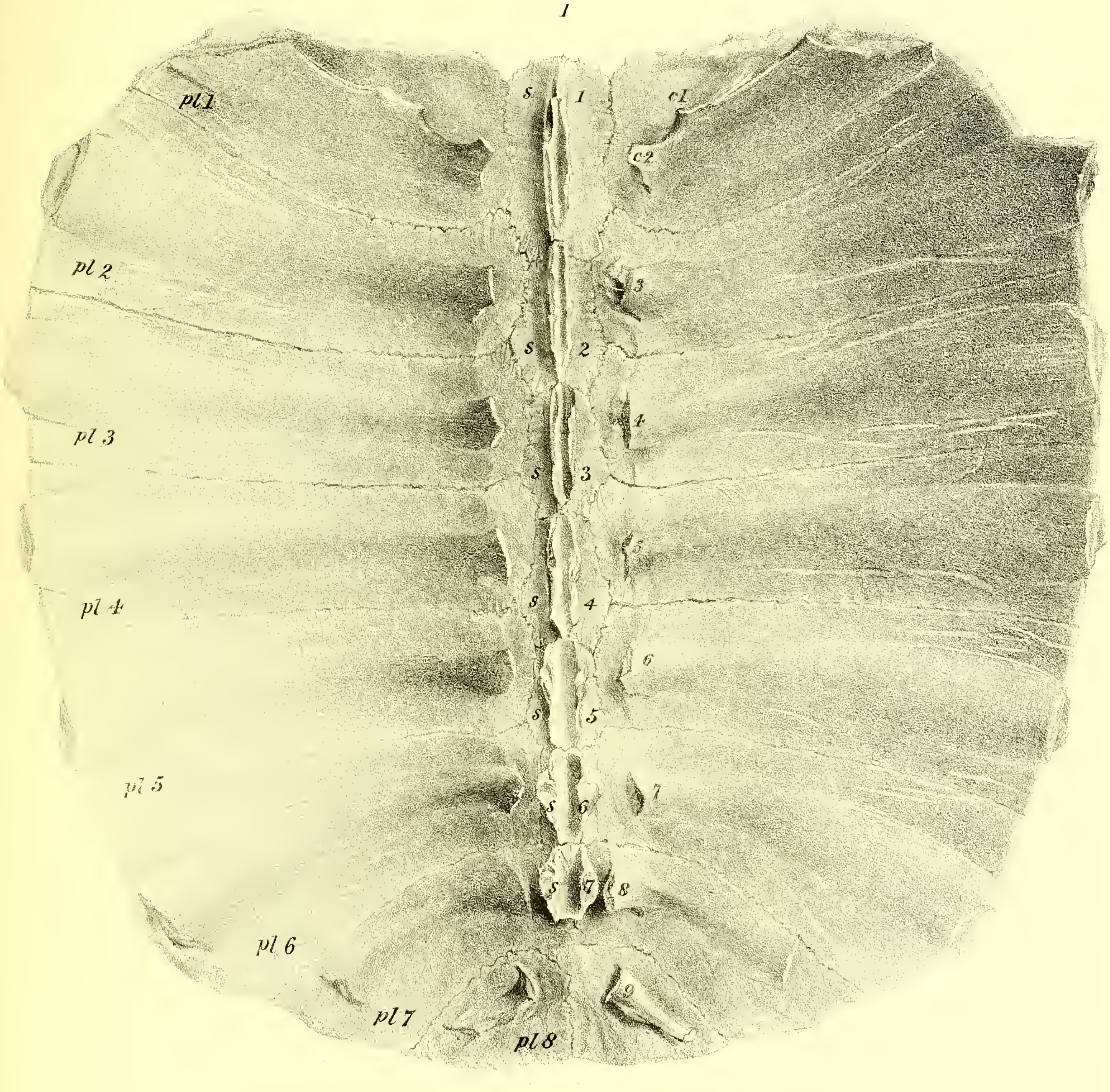
   *s*1—*s*7. The first to the seventh neural plates, with the connate neural spines and arches.

   *pl*1—*pl*8. The eight costal plates of the right side.

   *c*1. The place of attachment of the outer end of the first dorsal rib.

   *c*2—9. The portions of the consecutive dorsal ribs that become connate with the costal plates.

2. Transverse contour of the upper surface of the carapace.



½ Nat. size.

From Nature on Stone by J. Erxleben

TAB. XVIII.

Trionyx incrassatus.

Fig.

1. Upper or outside view of the fore part of the carapace with the nuchal plate, half nat. size.

    ch. The nuchal plate.

    *s*1. The first neural plate.

    *s*2. The second neural plate.

    *pl*1—*pl*3. The three anterior costal plates of the left side.

2. Under or inside view of the same specimen.

    ch. The nuchal plate.

    *s*1. The first neural plate connate with the neural spine of the second dorsal vertebra, of which part of the under surface of the centrum is here preserved and shown.

    *s*2. The second neural plate, with the connate neural arch of the third dorsal vertebra.

    *pl*1—*pl*3. The three anterior costal plates of the right side.

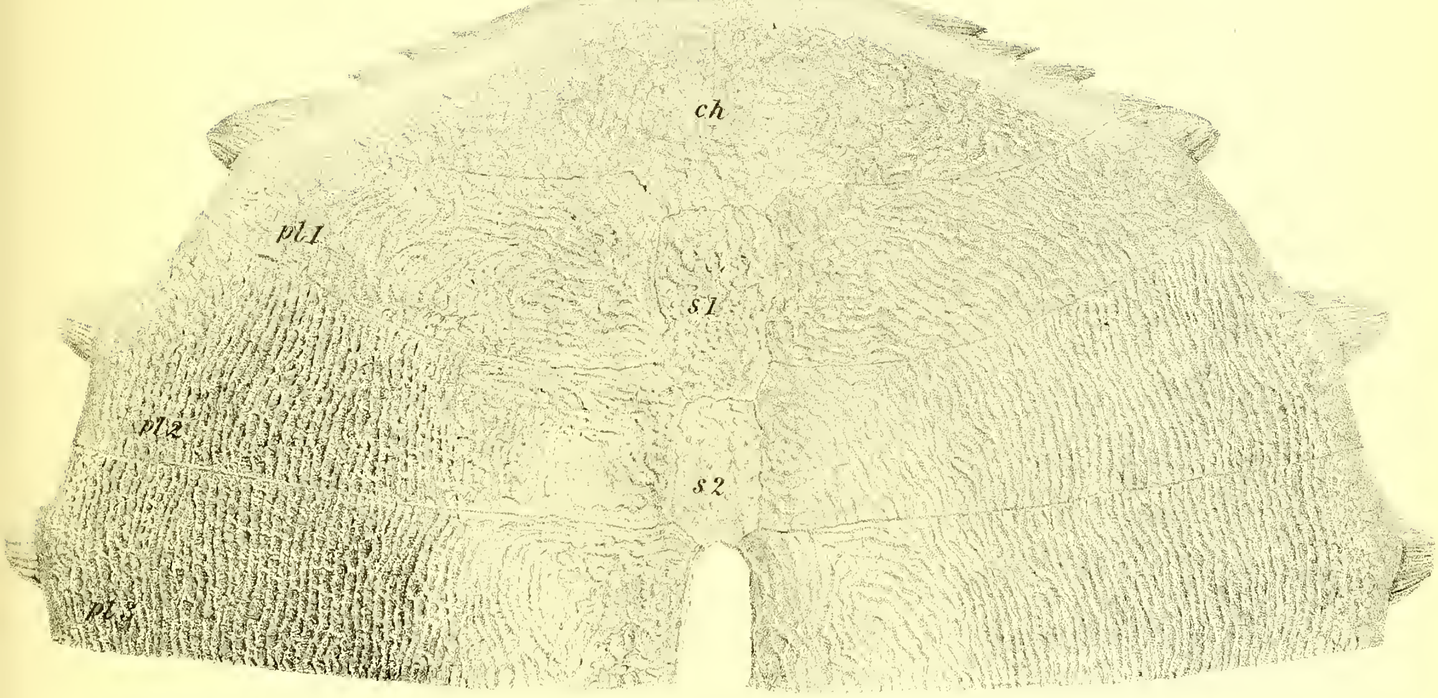
    *c*1. The place of attachment of the outer end of the first dorsal rib.

    *c*2. The portion of the second dorsal rib that becomes connate with the first costal plate. *c*2′. The extremity of the rib that again becomes free.

    *c*3. The third rib attached to the second costal plate.

    *c*4. The fourth rib attached to the third costal plate.

1



2

½ Nat. size

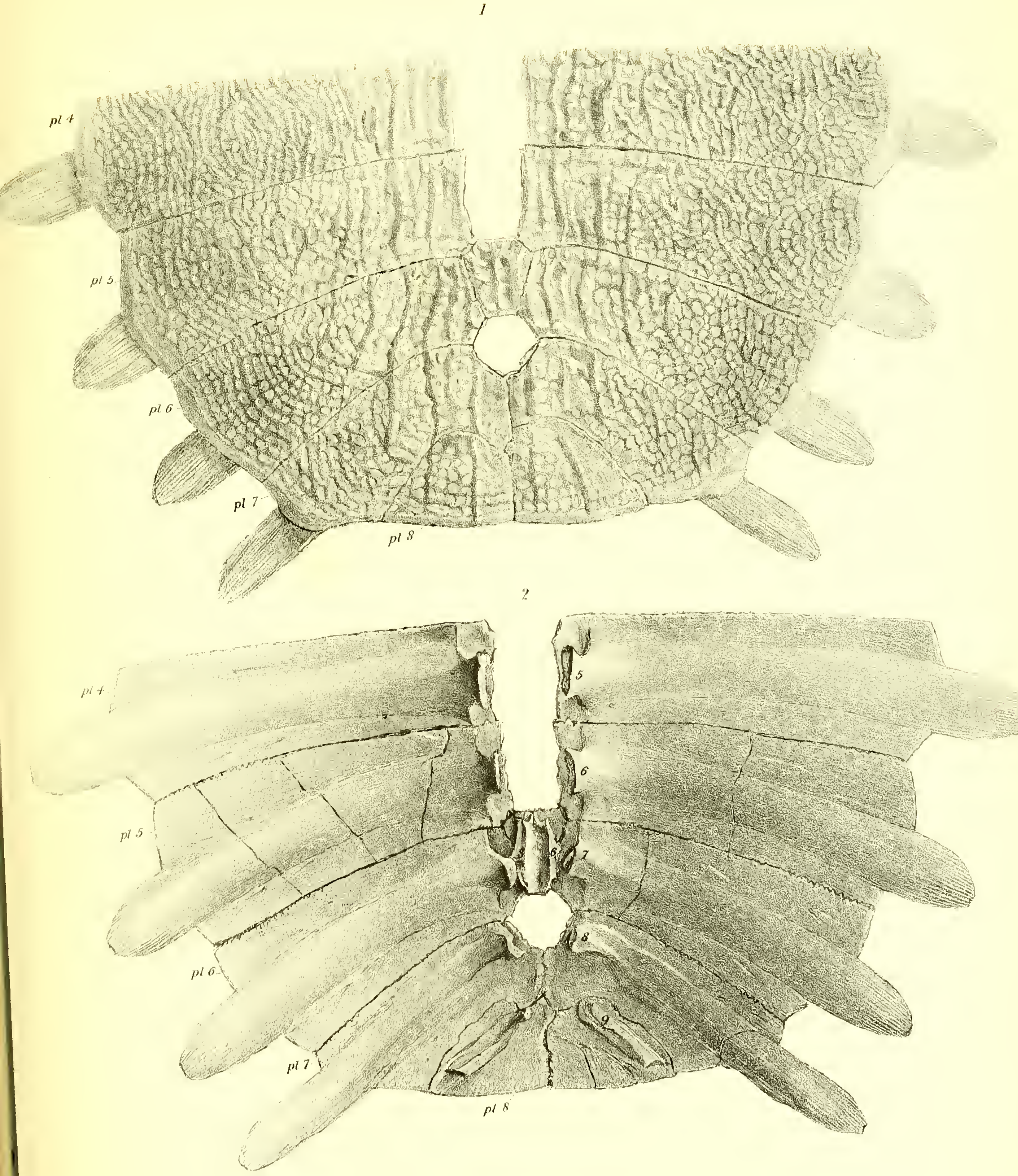
TAB. XVIII*A*.

Trionyx rivosus.

Fig.

1. Outside view of hinder half of the carapace, nat. size.
   *pl*4—*pl*8. The fourth to the eighth costal plates inclusive.

2. Inside view of the same specimen.
   *pl*4—*pl*8. The fourth to the eighth costal plates inclusive.
   5—9. The ribs (fifth to the ninth dorsal inclusive) connate with the above costal plates.
   *s*6. The neural arch confluent with the sixth neural plate.



Day & Son lith.[rs] to the Queen

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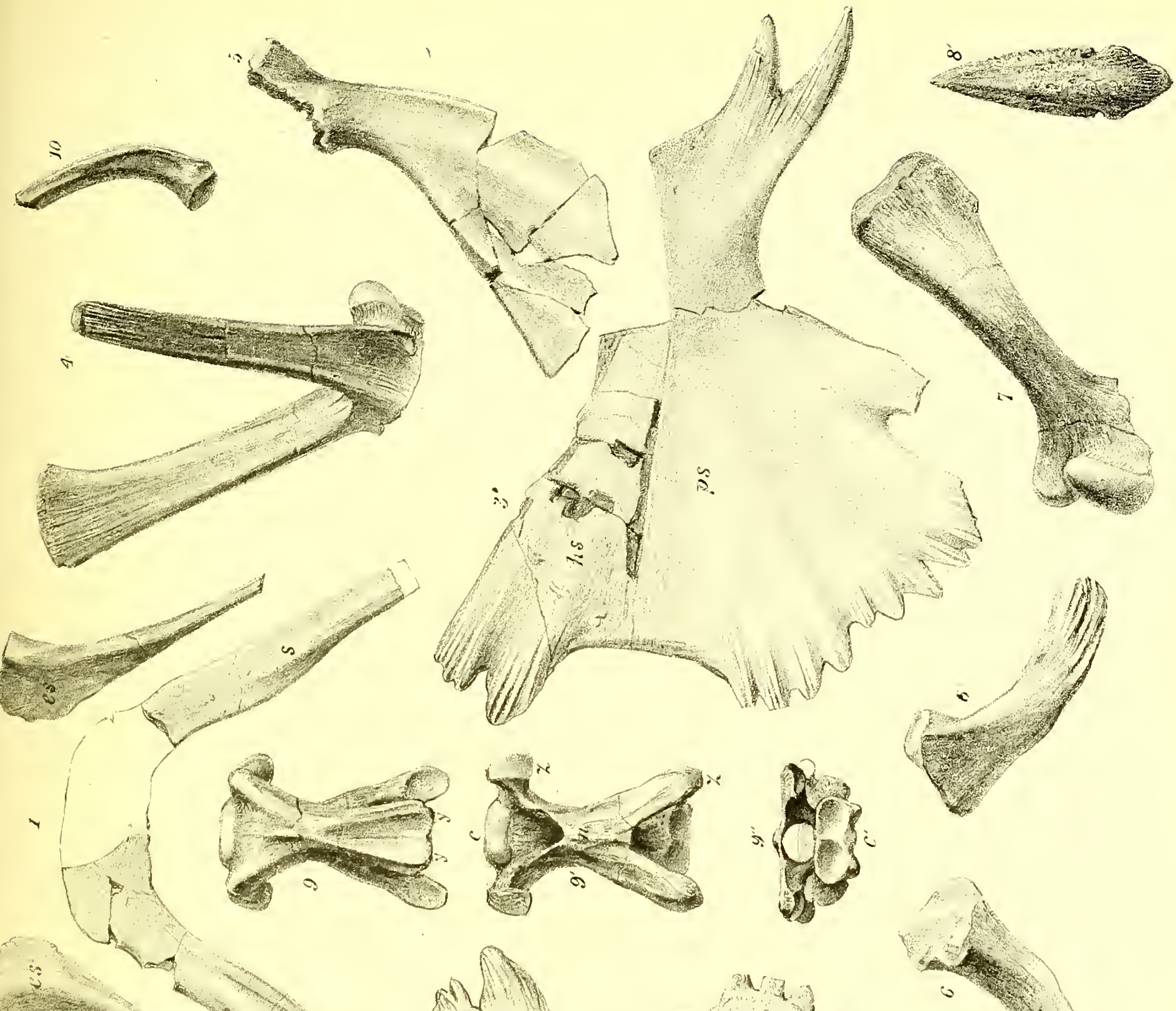
TAB. XIX.

Trionyx incrassatus.

The parts are figured half the nat. size.

Fig.

1. Entosternal.
2. Episternal, under side.
2′. Ditto. upper side.
3. Part of right hyosternal, and the hyposternal, under or outer side.
3′. *hs*, Ditto, and *ps*, ditto, upper side.
4. Two views of the scapula (51), and connate acromial clavicle (58); 4″ shows the osseous structure of the end of the scapula, nat. size.
5. The coracoid.
6, 6′. Two views of the ilium.
7, 7′. Two views of the femur.
8, 8. Two views of an ungual phalanx, nat. size.
9. Under view of the sixth cervical vertebra; *y*, *y*, the hypapophyses.
9′. Upper view of the same vertebra; *c*, the anterior convex articular surface of the centrum; *n*, the neural arch; *z*, *z*, the zygapophyses (oblique or articular processes).
9″. Back view of the same vertebra, showing the double concavity of the articular surface.



½ Nat. size.

TAB. XIX+.

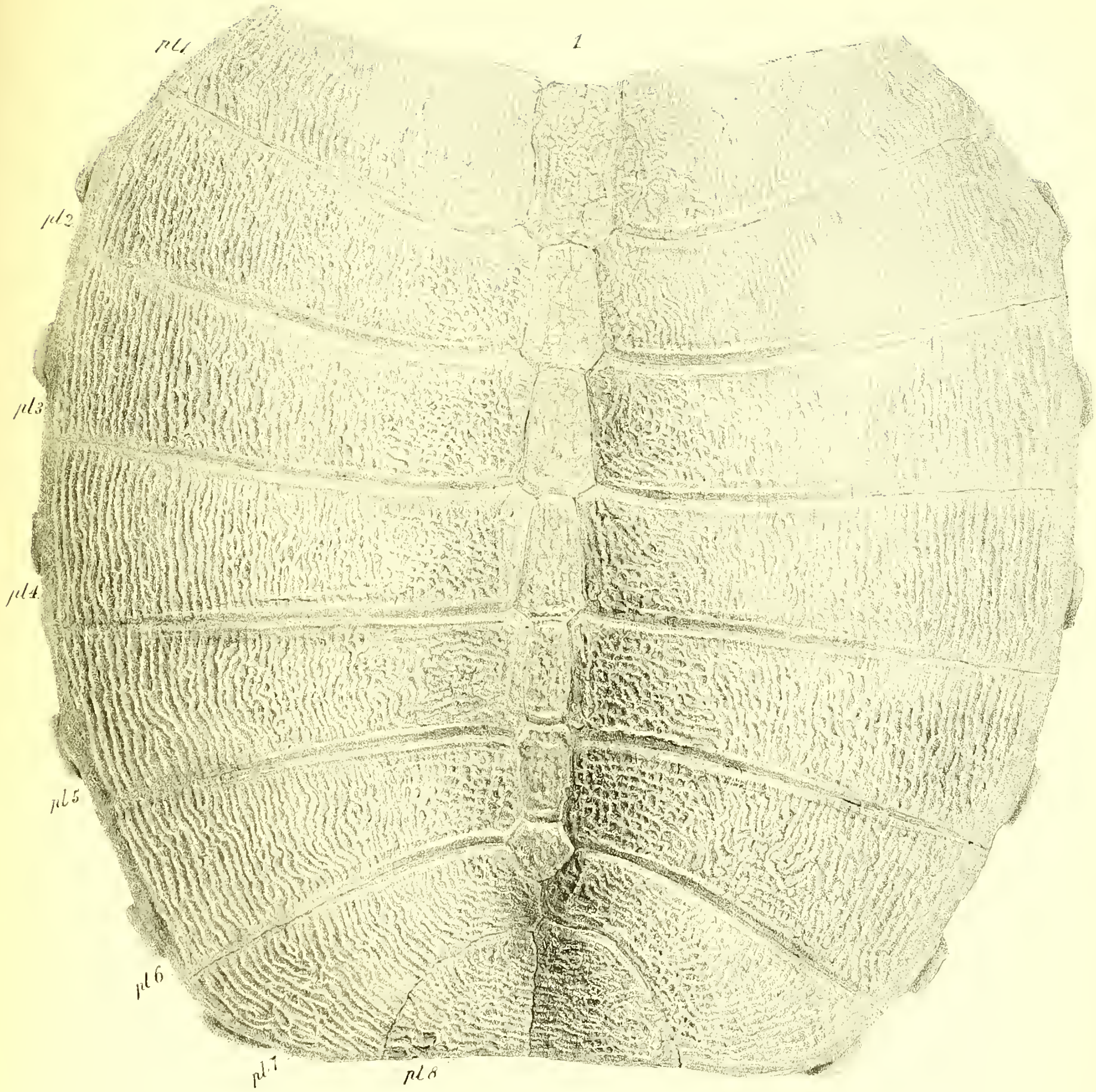
Trionyx marginatus.

Fig.

1. Upper view of the carapace, wanting the nuchal plate, half the nat. size. The letters and figures indicate the same parts as in Tab. XVI.

2. Outline of the transverse curvatures of the upper surface of the carapace.

1

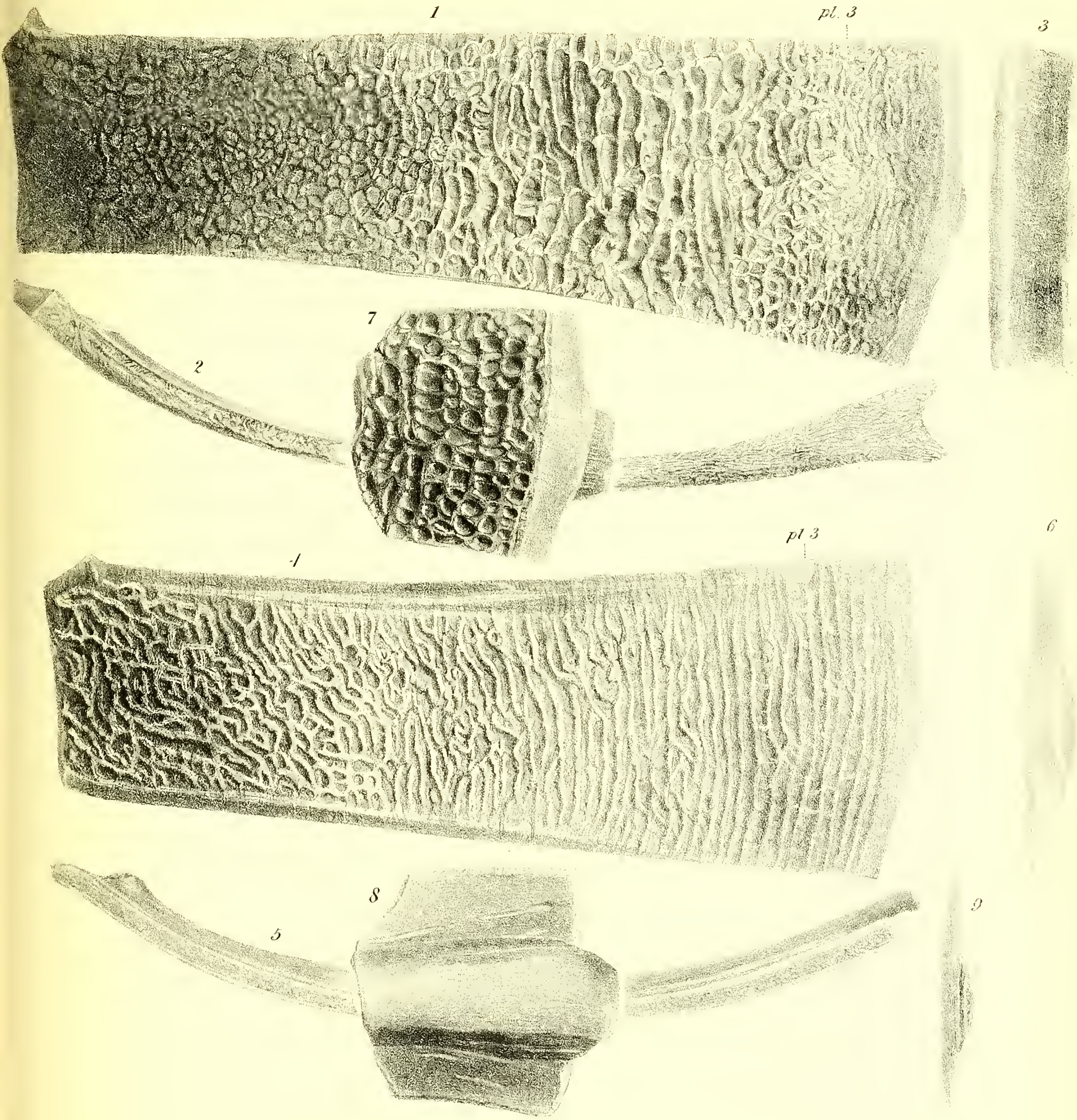


2

TAB. XIX*B*.

Fig.

1. Upper surface of the third costal plate, right side, of the *Trionyx circumsulcatus*, nat. size.
2. Articular margin of ditto; showing the natural curve and thickness of the plate.
3. Peripheral margin of ditto; showing the groove.
4. Upper surface of the third costal plate, right side, of the *Trionyx marginatus*.
5. Sutural margin of ditto.
6. Peripheral margin of ditto.
7. Upper surface of a fragment of a costal plate of the *Trionyx pustulatus*, nat. size.
8. Under surface of ditto, showing the large and prominent adherent rib.
9. Peripheral margin of ditto.



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TAB. XIX *C.*

Trionyx planus.

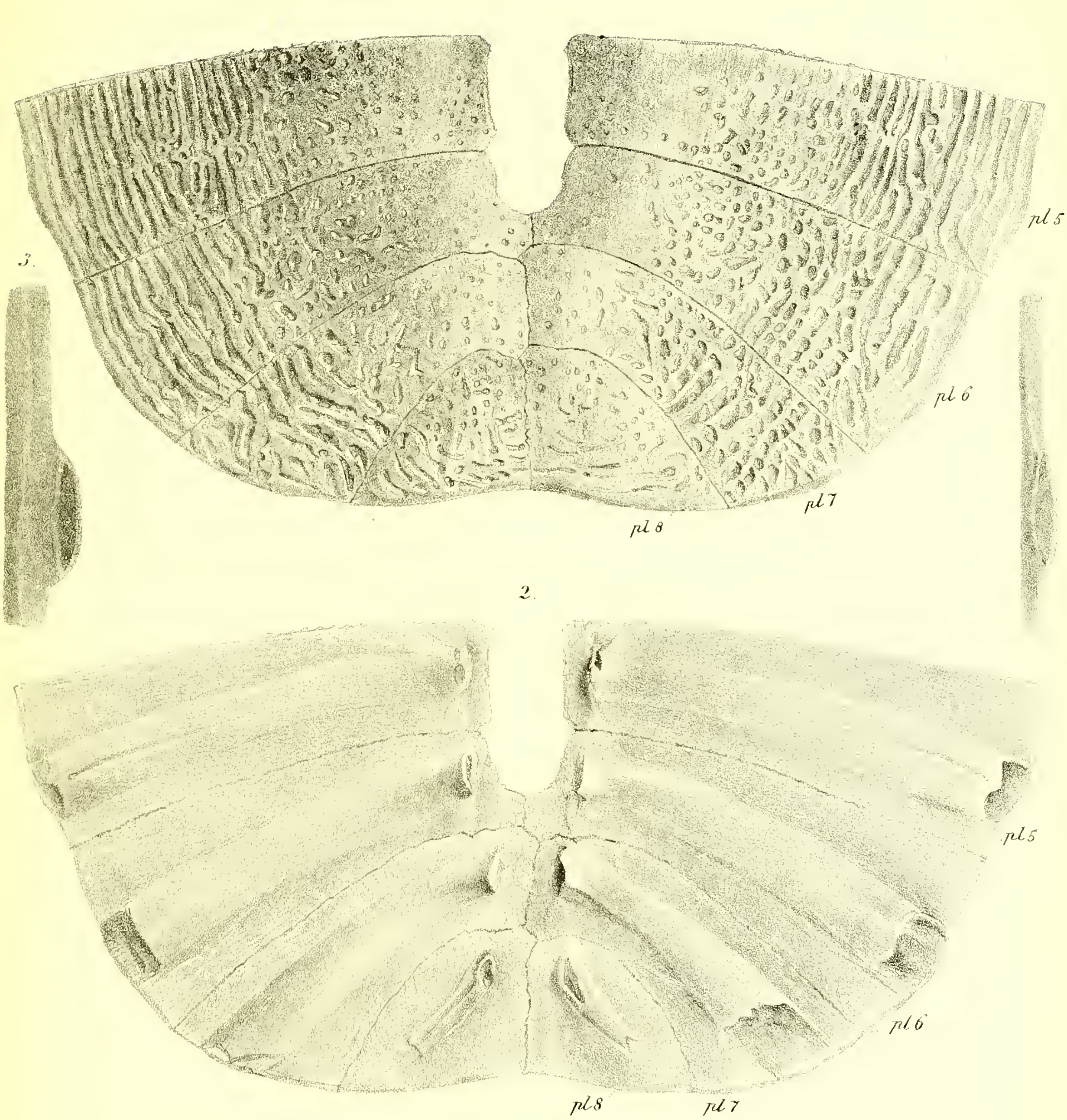
Fig.

1. Upper view of the hind part of the carapace, half the nat. size.

2. Inside view of the same specimen ; *pl*5—*pl*8, the fifth to the eighth costal plates inclusive.

3. Peripheral border of the fifth costal plate, nat. size.

4. Peripheral border of the fifth costal plate of the *Trionyx Barbaræ,* showing the difference in their relative thickness.



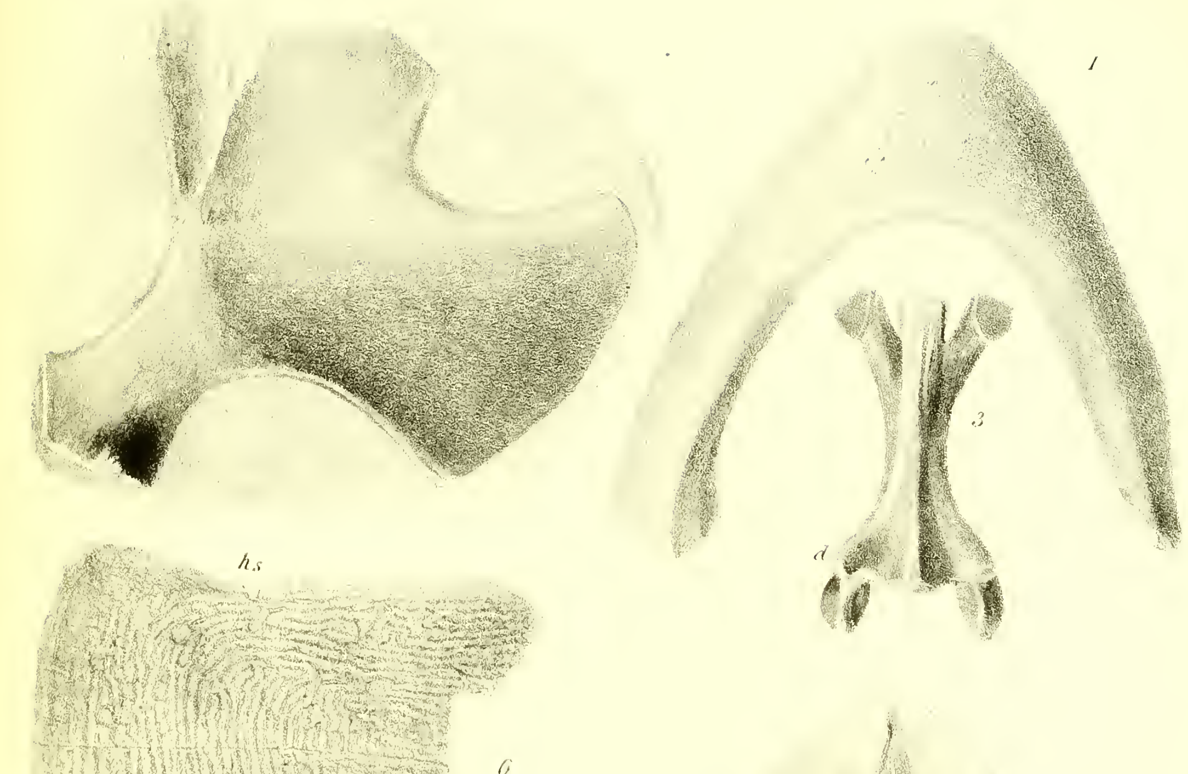
...n Nature & on Stone by J. Erxleben

Day & Son

TAB. XIX*D*.

Fig.

1. Under view of the lower jaw of a turtle (*Chelone*), nat. size. (Hordwell Cliff).
2. Upper view of the same speeimen.
3. Upper view of the fourth eervieal vertebra of a *Trionyx*; *d,* diapophysis. Nat. size.
4. Side view of the same speeimen (Hordwell Cliff).
5. The left os pubis of a *Trionyx*, nat. size (Hordwell Cliff).
6. Part of the plastron of *Trionyx planus*, half the nat. size; *hs*, hyosternal; *ps*, hyposternal.
7. Right hyposternal of a *Trionyx*, from Bracklesham, half the nat. size. (In the Colleetion of Frederiek Dixon, Esq., F.G.S.)


5
1
3
d
h.s
6
2
p.s
7
f p.s
4

TAB. XX.

Emys Comptoni, nat. size.

Fig.

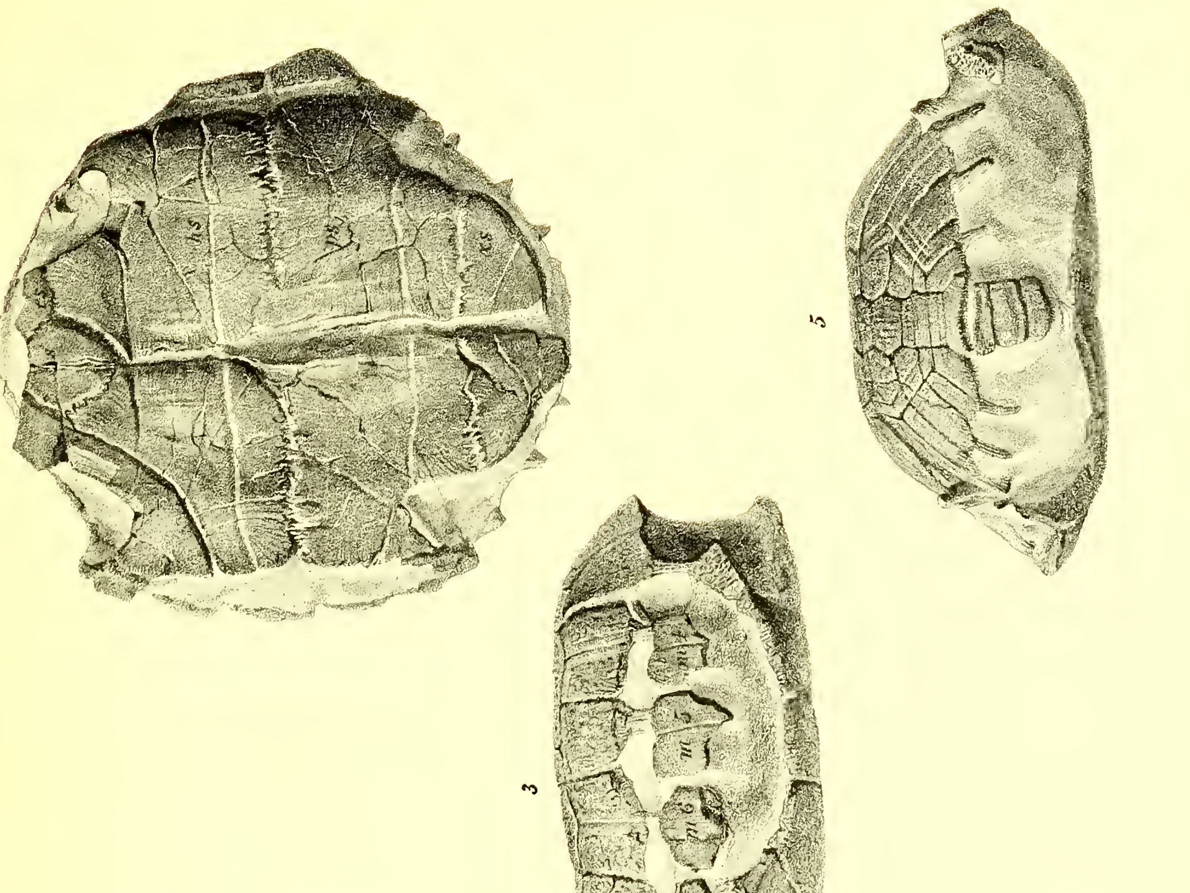
1. Upper view of the carapace.

2. Under view of the plastron.

3. Side view, showing the marginal plates, m_4—m_7.

4. Front view.

5. Back view.



Dinkel del. et lith.

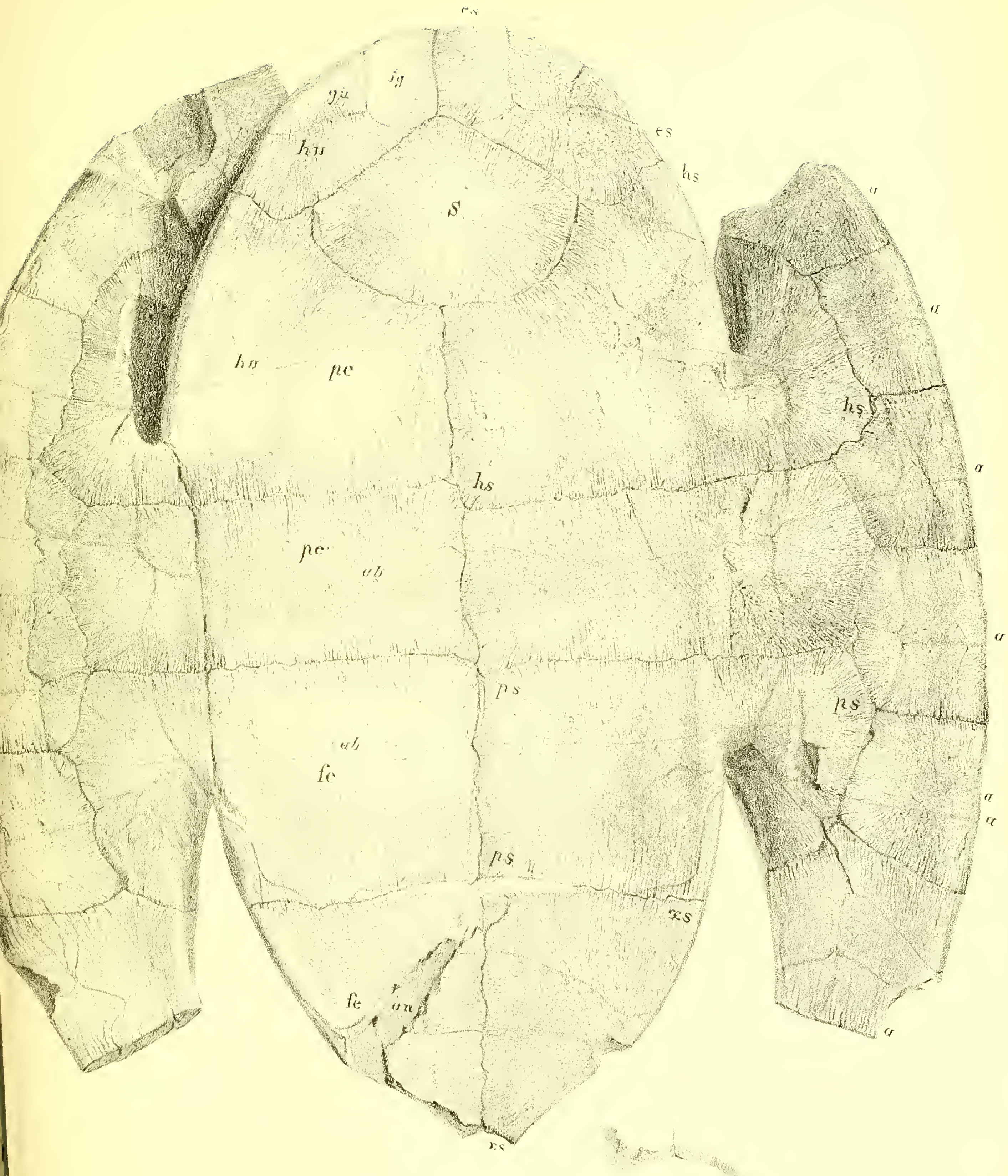
TAB. XXI.

Platemys Bullockii, half the nat. size.

The plastron and some of the marginal plates, *a a*.

s. Entosternal.
es. Episternals.
hs. Hyosternals.
ps. Hyposternals.
xs. Xiphisternals.
ig. Intergular scute.
gu. Gular scutes.
hu. Humeral scutes.
pe. Pectoral scutes.
ab. Abdominal scutes. The impression between these and the pectoral scutes crosses the intercalated supernumerary bones between the hyosternals and hyposternals.
fe. Femoral scutes.
an. Anal scute.

Where the bones or scutes are in pairs, the figures or letters are placed on one of each pair.



Dinkel del. et lith.

Day & Son lith^rs to the Queen

TAB. XXII.

Emys lævis, two thirds the nat. size.

Fig.

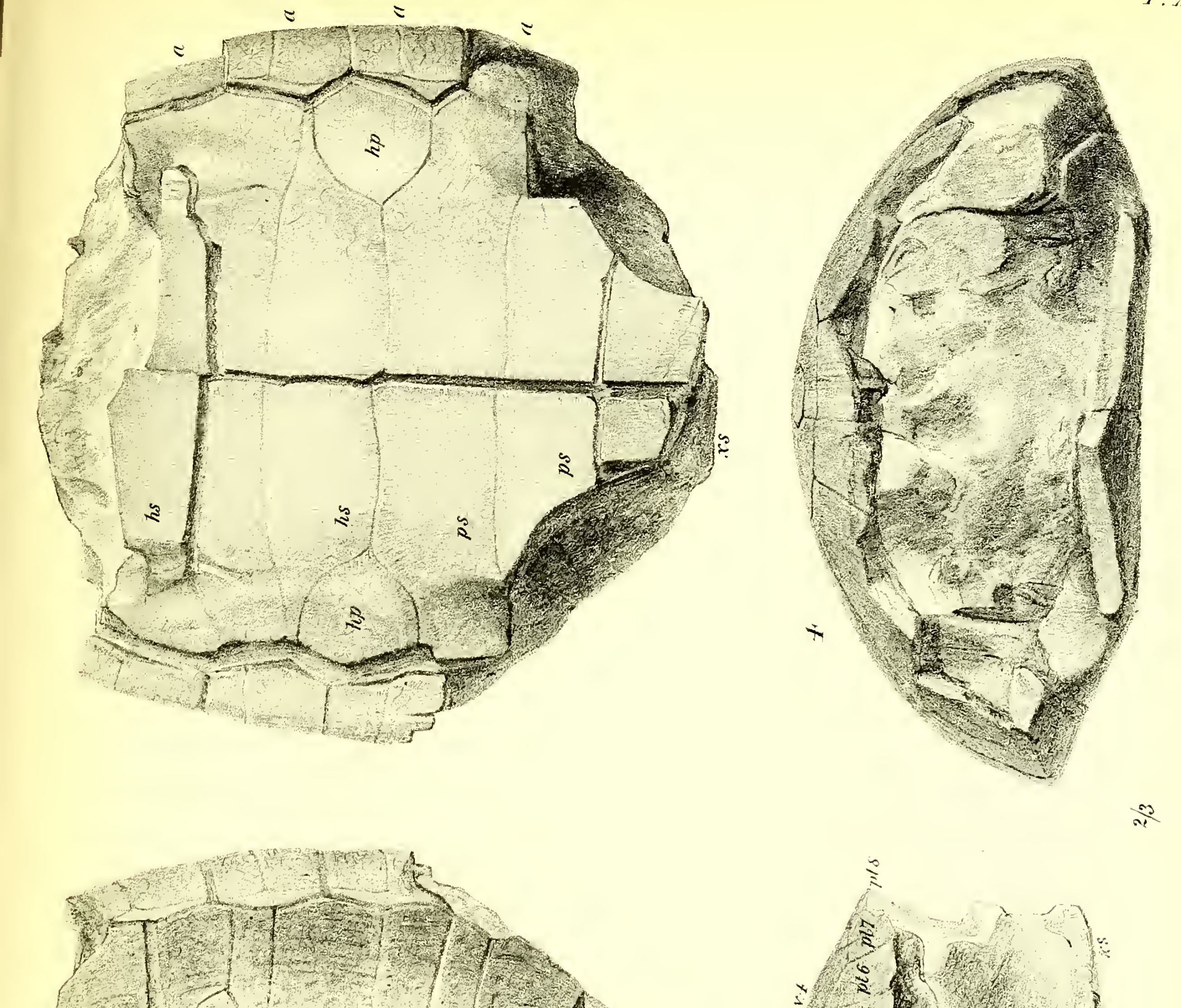
1. Upper view of carapace.

2. Under view of plastron.

3. Side view

4. Front view, showing the curvature and depth of the specimen.

The letters and figures signify the same parts as in the preceding figures; *hp,* the accessory pieces of the plastron.



3

4

2/3

TAB. XXIII.

Platemys Bowerbankii, half the nat. size.

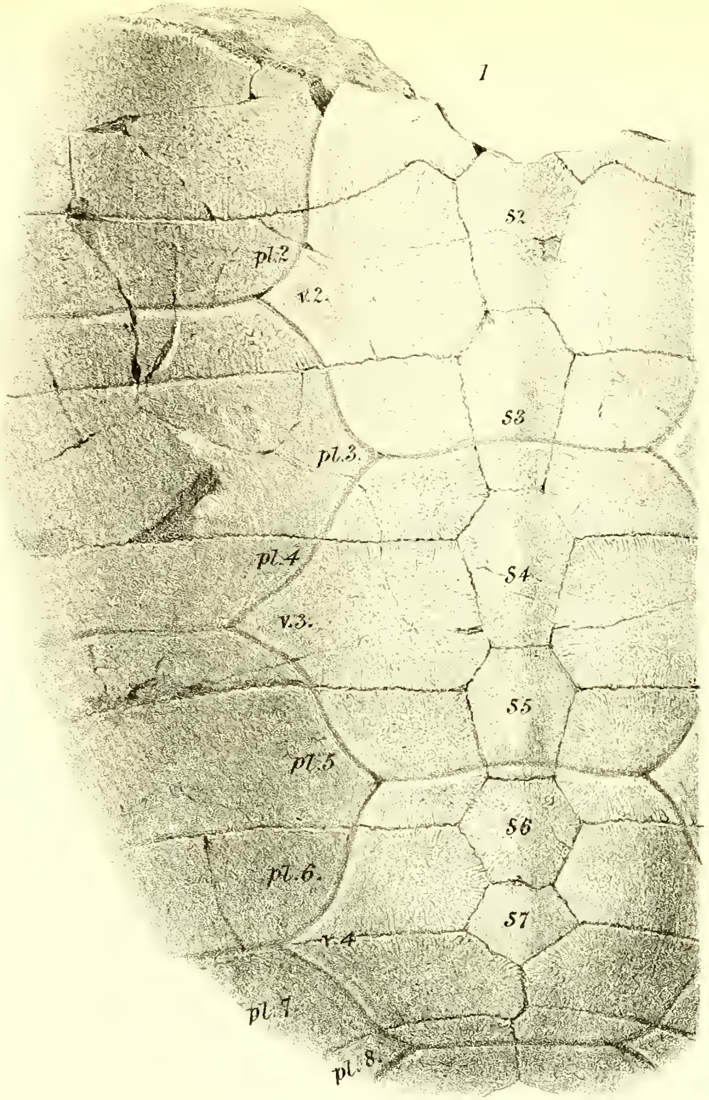
Fig.

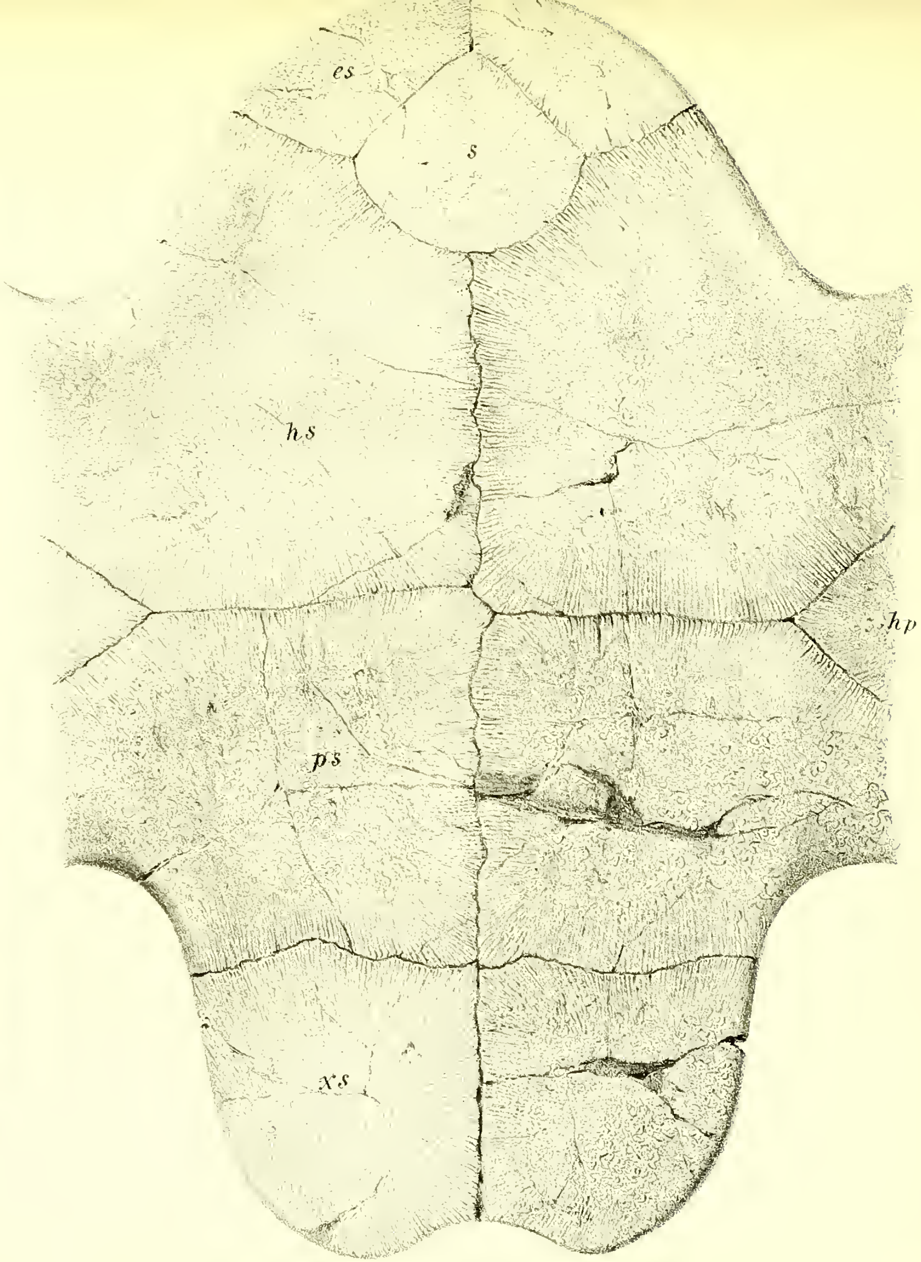
1. The mutilated carapace.

2. The plastron.

The letters and figures indicate the same parts as in the preceding Table.

1


pl.2
v.2.
s2
s3
pl.3.
pl.4
s4
v.3.
s5
pl.5
s6
pl.6.
s7
v.4
pl.7
pl.8.


es
s
hs
hp
ps
xs

TAB. XXIV.

Emys testudiniformis, nat. size.

Fig.

1. Nuchal plate.

2. Upper surface of the third neural plate.

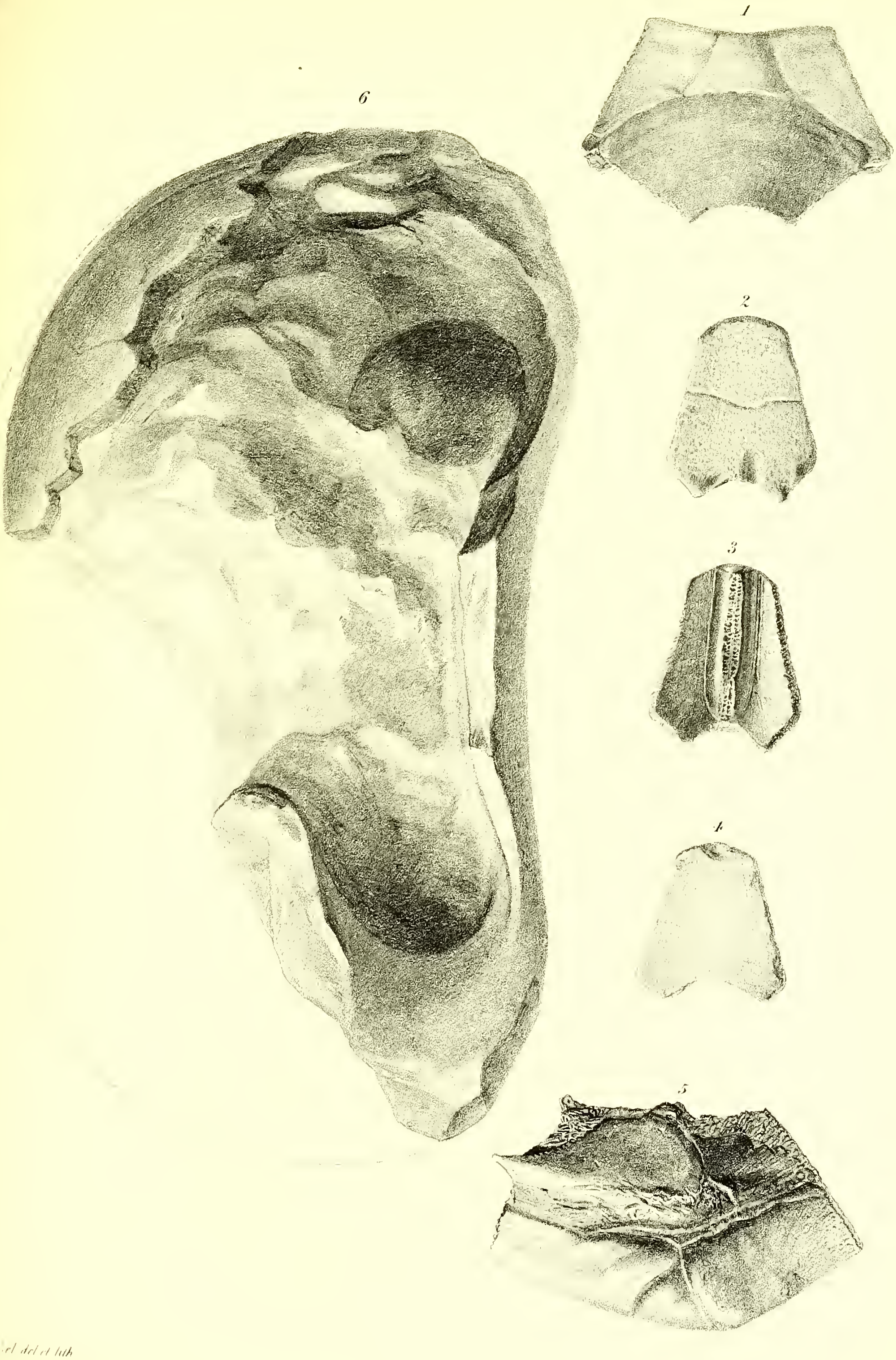
3. Under surface of ditto.

4. Upper surface of the fifth neural plate.

5. A posterior marginal plate.

6. Front view of a mutilated cuirass in which the carapace has been slightly depressed ; the natural curve, across the middle, is indicated by the outline.

T.XXIV.



…el del et lith

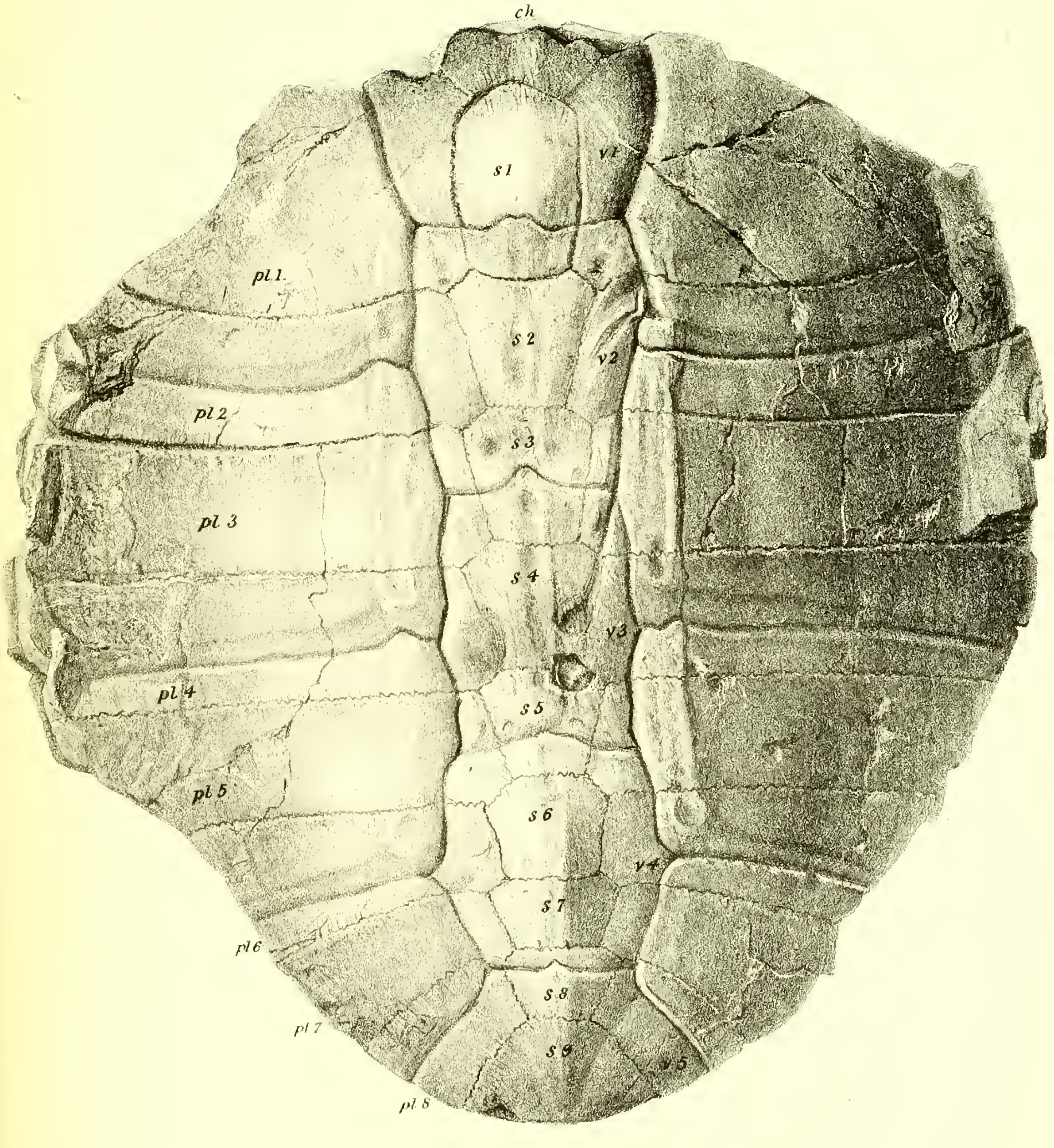
Day & Son lithrs to the Queen

TAB. XXV.

Emys bicarinata, two fifths the nat. size.

The letters and numbers on the carapace, the upper surface of which is figured, indicate the same parts as in the previous figures.

The transverse contour of the carapace is given in outline above.

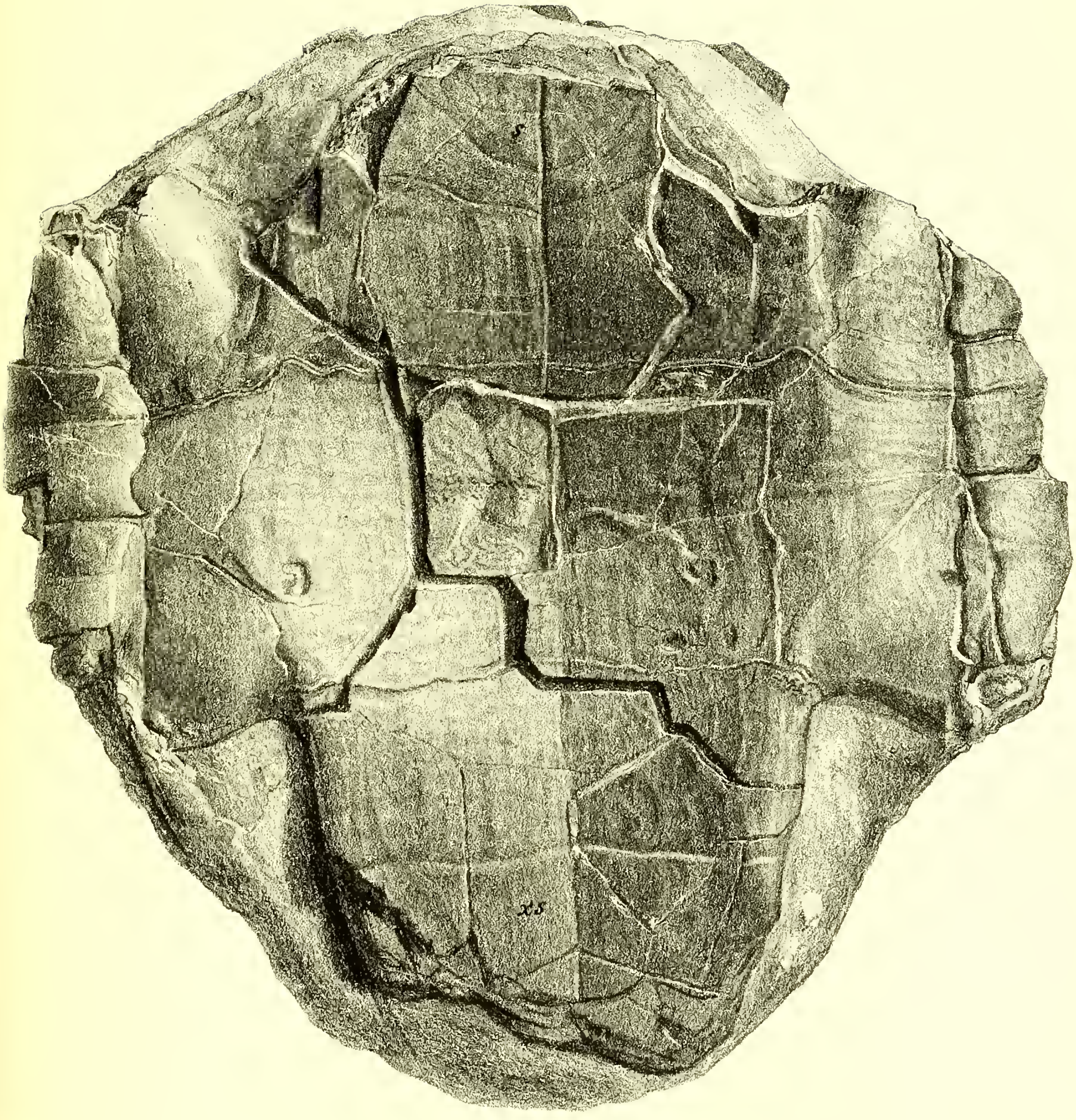

ch
s1
v1
pl 1.
s 2
v2
pl 2
s 3
pl 3
s 4
v3
pl 4
s 5
pl 5
s 6
v4
s 7
pl 6
s 8
pl 7
s 9
v 5
pl 8

[illegible] Nat Size

TAB. XXVI.

Emys bicarinata, two fifths the nat. size.

The plastron; *s*, the entosternal piece.
xs, the xiphisternals.



⅔ Nat. Size

TAB. XXVII.

Emys crassus, two thirds the nat. size.

Fig.

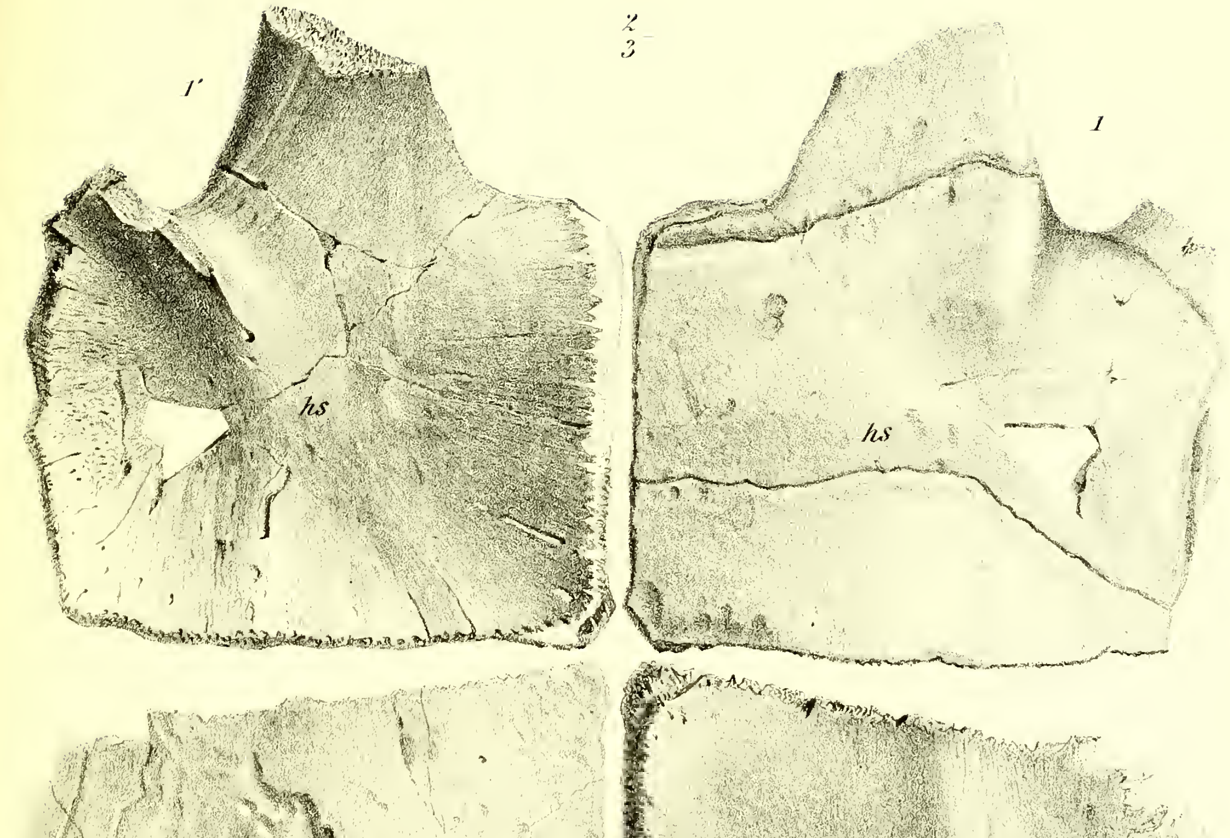
1. Outside view of the left hyposternal.

1′. Inside view of ditto.

2. Outside view of right hyosternal.

2′. Inside view of ditto.

3. Sutural border of hyosternal, nat. size.



Nat. Size.

Dinkel del et lith

Day & Son, lith.rs to the Queen

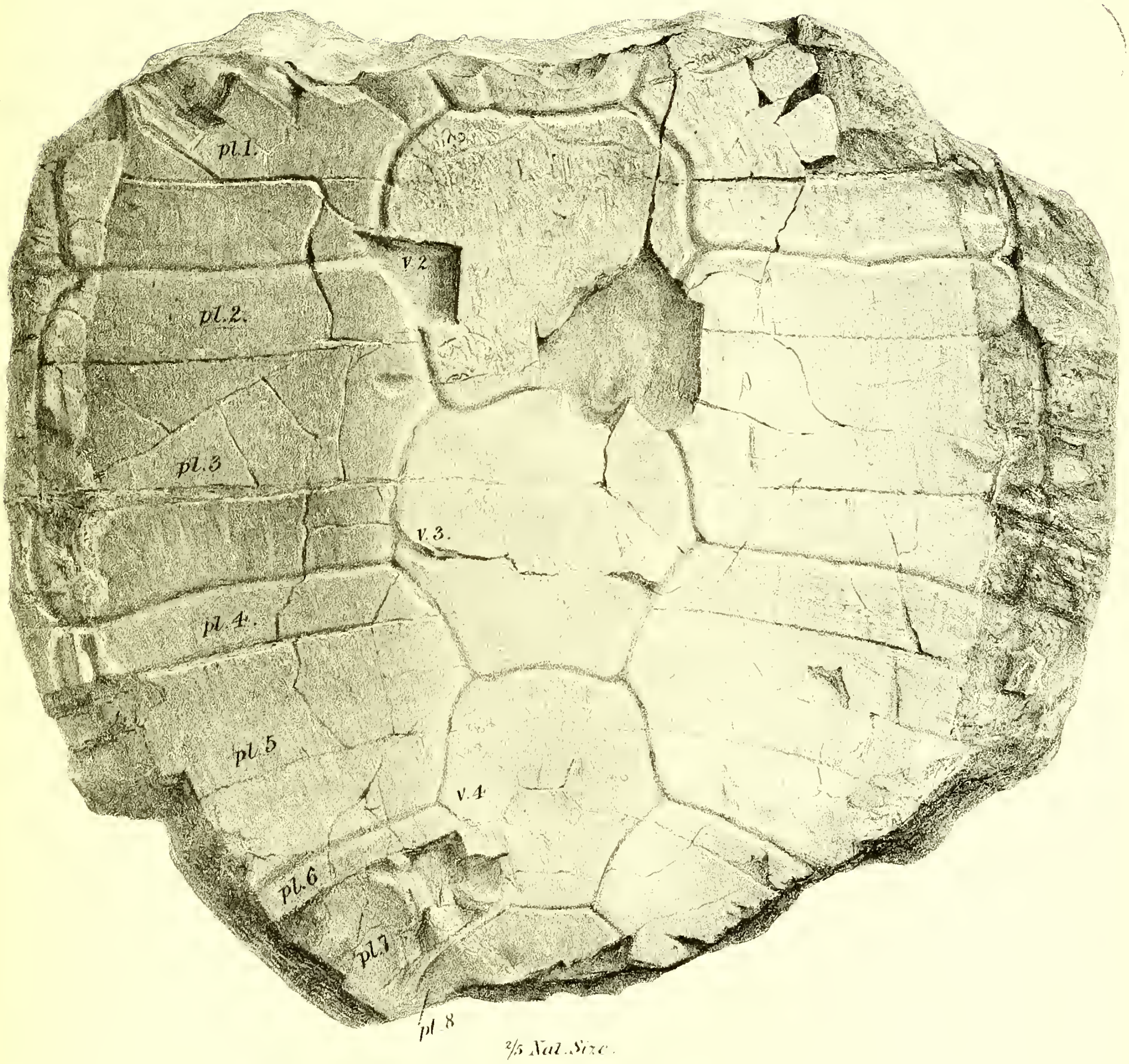
TAB. XXVIII.

Emys Delabechii, two fifths the nat. size.

Upper or outside view of the carapace; the transverse curve is given in the outline above.

pl 1—*pl* 8. The eight costal plates of the left side.

v 2—*v* 4. The second to the fourth vertebral scutes inclusive.



2/5 Nat. Size.

Dinkel del. et lith.

Lavigne lith. to the Queen

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

LONDON:

MDCCCXLIX.

ALÆONTOGRAPHICAL SOCIETY.

THE EOCENE MOLLUSCA.

BY

FRED. E. EDWARDS.

PART I.—CEPHALOPODA.

1849.

A MONOGRAPH

OF

THE EOCENE MOLLUSCA,

OR

DESCRIPTIONS OF SHELLS FROM THE OLDER TERTIARIES
OF ENGLAND.

BY

FREDERIC E. EDWARDS.

PART I.

CEPHALOPODA.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1849.

PRINTED BY C. AND J. ADLARD, BARTHOLOMEW CLOSE.

A MONOGRAPH

OF THE

MOLLUSCA FROM THE EOCENE FORMATIONS OF ENGLAND.

FIRST CLASS—*CEPHALOPODA.* Cuvier.

Mollusca brachiata. *Poli.*
Céphalopodes. *Lamarck; Férussac.*
Céphalophores. *De Blainville.*

The Cephalopoda form the first class of Molluscous Animals in the system proposed by Cuvier, and consist of the several encephalous mollusca whose organs of reptation are attached to the head. Possessing an organization more complicated and more fully developed than that of the other molluscs, they have a higher rank in the scale of existence. In a descending series they immediately succeed the Vertebrata.

It is in this class that the latest indication of an internal skeleton will be found. Among the more highly organized of the Cephalopods, the cephalic ganglia, to which, from their importance and development, the term *brain* may still be applied, are surrounded and protected by a cartilaginous process, called *the cranial cartilage*, analogous with the cranium of a vertebrate animal, and in which the muscles of the arms and tentacula are inserted. Other cartilages, subservient to the muscles of the funnel and of the fins, where those organs exist, will be found in other parts of the body, and may be said to represent, in rudiment, those portions of the skeleton which in the vertebrate animals sustain their locomotive organs.

The Cephalopods are eminently social animals; they are all predatory and voracious in the extreme, and appear to be nocturnal or crepuscular in their habits. Some, the more highly organized, inhabit the deep seas only; others frequent the coasts or shallow seas, or conceal themselves in holes in the rocks. M. d'Orbigny, to whose recent work entitled 'Mollusques vivants et fossiles' I am largely indebted, shows that to these various habits the zoological peculiarities of the different genera are referable; and he distinguishes the animals as pelagic (pelagiens), or littoral (côtiers), according to the fact of their frequenting the deep sea or the coasts.

The Cephalopoda have a distinct head, surrounded by arms or tentacula; they possess organs of sight and hearing, closely resembling those of vertebrate animals, and they are endowed with the sense of smell. The eyes are placed on the sides of the head, and in one of the two orders into which the animals are divided (the Dibranchiata) are, generally, lodged in an orbital cavity in which they move freely; in some genera, however, they are united to the outer integument, and are then incapable of motion. When lodged in orbital cavities, they exhibit two distinct modifications, of which M. d'Orbigny has availed himself for the subdivision of the order into two groups (called respectively *Myopsidæ** and *Oigopsidæ*†). In the first modification, which is found among the littoral Cephalopods, the eyes are wholly covered by the skin of the head, which becomes thin where it passes over the ball of the eye; in the other modification, which characterises the pelagic species, the orbital cavity is largely open, and the eyes are in contact with the water.

In the tetrabranchiate Cephalopod, whose food is found principally at the bottom of the sea, and to whom enlarged vision would be comparatively useless, the eye is not lodged in an orbital cavity, but pedicillated, and assumes a simpler structure, approaching that of the inferior mollusc.

These animals possess an external auditory opening, generally protected by an external ear more or less complicated in structure. The organs of smell are supposed to reside in certain pores or sacs, opening externally, termed by M. d'Orbigny *aquiferous pores* (ouvertures aquifères), which are divided into *cephalic, oral, anal,* and *brachial* pores according to their position, and are used by him as generic distinctions. The mouth is terminal, and is furnished with two strong, horny beaks or jaws termed *mandibles,* working vertically upon each other like the bill of a parrot, with which they are usually compared.

The body is inclosed in a thick membranous skin or mantle, united along the belly of the animal so as to form a muscular bag or sac, open at the upper extremity, and containing the branchial apparatus and viscera. In its general shape it is round, or more or less elongated, and cylindrical or depressed. To this body, distinguished as the posterior portion of the animal, the anterior or cephalic portion, consisting of the head and the arms or tentacula it sustains, is attached by one or more ligaments, some internal, others formed by the continuation of the skin of the body, and termed *cervical* or *lateral ligaments,* according to their position. The condition of these ligaments varies with the habits of the animal, and upon it generic characters are founded. They attain their greatest strength in the littoral Cephalopods, and in some genera afford a sufficient attachment between the head and the body; but in the Cephalopods more or less pelagic, in which the free and independent use of the organs of prehension, and a simultaneous active exercise of the bodily locomotive function, would be materially impeded by an extensive permanent attachment, the ligaments are considerably reduced; so much so, in fact, that they would afford a very imperfect

* Myopsidæ; from *μυω* claudo, *οψις* visus.

† Oigopsidæ; from *ὄιγω* aperio, *οψις* visus.

guard against the resistance caused by the rapid motion through the water of a mass so large as the cephalic portion of the animal. To obviate this defect, a peculiar apparatus is found in various Cephalopods, which, capable of being instantly brought into action, provides an additional and firm attachment of the head to the body. This apparatus is variable in form, and, except in three genera in which it is not found, forms one of the most certain generic characters. It consists of one or more cartilaginous or fleshy protuberances, placed on each side either of the inner surface of the body or of the base of the head, which fit into corresponding holes or depressions formed for their reception in the opposite part of the head or body. This apparatus, termed by M. d'Orbigny the apparatus of resistance (l'appareil de resistance), has relation to the swimming power of the animal, and is more or less complicated as that increases or diminishes.

The respiratory apparatus consists of two or four lamelliferous branchiæ or gills, lodged in chambers contained in the visceral sac, but separated from the viscera by a membranous partition. The number of these gills has been adopted by Professor Owen as an ordinal distinction ; and, in the system of classification proposed by him, to which I shall hereafter refer, the Cephalopods are divided into *dibranchiate* and *tetrabranchiate* orders according to the fact of their possessing two or four branchiæ. Into the chambers containing the gills, the water is freely admitted by a valvular aperture, and having served the purpose of respiration, flows, or is forcibly ejected by the muscular contraction of the body, through the excretory tube or funnel (*infundibulum*). The water thus expelled in streams more or less powerful and frequently repeated, at the will of the animal, causes a retrogressive movement, which forms its principal mode of locomotion, from which circumstance the tube itself is called by M. d'Orbigny the *locomotive tube.* The body thus becomes the most important locomotive agent ; and as its size and shape must materially influence the retrogressive motion, we can readily conceive that they will have relation to the exigencies of the animal for swimming. Thus the pelagic species, in which the body, from its comparative size, and its cylindrical form and tapering extremity, is adapted to contain a large quantity of water, and to move through the sea with facility, are, as their necessities would require, pre-eminently powerful swimmers ; while, on the other hand, in the littoral species, to which great retrogressive power would be not only unnecessary, but a source of frequent injury, the body is small and rounded, or depressed, so as to afford a broad surface on which the animal can rest upon the ground.

Among the dibranchiate Cephalopods the circulation is performed by the agency of a central or systemic heart, of two lateral hearts, subservient to the propulsion of the blood through the branchiæ, and thence called the *branchial* hearts, and of a venous system consisting of two principal vessels, *venæ cavæ,* contained in a cavity called by Professor Owen the *pericardium,* and communicating freely with the branchial chambers, and of other subordinate trunks or vessels. In this cavity terminates the tube called the *siphon* or *siphuncle,* which perforates and traverses the chambers of all the multilocular shells, whether external or internal,* and by means of which, as it has generally been supposed, the animal can diminish or increase the specific gravity of the shell, and so facilitate its rising or sinking in the water.

In the recent *Nautili,* the sole living representatives of the tetrabranchiate Cephalopods, the lateral hearts are wanting, the enlarged surface of the branchial apparatus rendering such additional means of circulation unnecessary.

The funnel or locomotive tube is placed beneath the head, and supports at its base the apparatus for resistance before noticed. Its functions are various: it conveys away the water inhaled for respiration after that object has been served, and, as we have already seen, becomes, at the will of the animal, the principal locomotive agent; it is also the excretory tube. The condition of this organ is used by Professor Owen as an ordinal character; in the dibranchiate Cephalopods the parietes of the funnel are entire, while in the tetrabranchiate Cephalopods they are disconnected along the ventral margins.

A peculiar provision for defence is found among the naked Cephalopods, which is denied to those protected by an external shell; this provision consists of an organ for secreting and expelling an inky fluid, by the effusion of which the animal, when alarmed, is enabled to discolour the surrounding water, and thus to facilitate or conceal its escape. The fluid is contained in a bladder-shaped sac, called the *ink-bladder,* and its presence may be regarded as a certain indication of the dibranchiate type of organization.†

In addition to the retrogressive power possessed by all the Cephalopods, and derived from the agency of the funnel, the decapodous genera are provided with lateral or terminal fins, more or less coriaceous, according as the habits of the animal are more or less pelagic or littoral. The motive function of the fins, however, appears to be secondary; those organs being used chiefly to sustain or steady the animal, and direct its course through the water. The position of the fins is used as a generic character.

The dibranchiate Cephalopods carry on their heads eight or ten arms, the place of

* In M. de Blainville's "Mémoire sur l'Animal de la Spirula et sur l'Usage du Siphon des Coquilles Polythalames," the siphuncle is described as a solid tendinous prolongation of the retractor muscles, by means of which the animal is enabled to withdraw the cephalic mass within a cavity formed by the anterior extremity of the mantle, and thus to regulate the specific gravity of the body. It appears, however, from Professor Owen's examination of two specimens of *S. Peronii* (*fragilis*), captured and brought home by Captain Sir Edward Belcher (see Zoology of the Voyage of the Samarang), that the soft or membranous siphon is in reality a *tube* continued from the calcareous siphon and the last chamber of the shell, through a semicircular aperture in the mantle, into the visceral cavity.

† M. d'Orbigny, after referring to these means of escape in the Sepiæ, says (Moll. Viv. et Foss., vol. i, p. 134), that he is far from believing that the faculty is enjoyed by every species; and that, in fact, if it exists among the Sepidæ, it is at the least doubtful among the other Cephalopods, who possess but a small quantity of the liquid, which they only expel when dying.

which, in the tetrabranchiate Cephalopod, is supplied by a multitude of tentacula grouped around the mouth. These arms or tentacula are organs as well of locomotion as of touch and prehension. In the dibranchiate Cephalopod the arms are furnished with suckers (*acetabula*), and are of two kinds, viz.: eight *sessile* arms encircling the mouth, and connected at the bases by a muscular web more or less broad; and two *tentacular* arms placed one on each side, and capable of considerable extension. The Octopods are furnished with the sessile arms only; the Decapods possess also the tentacular arms. The development of the sessile arms appears to be in inverse ratio with the retro-swimming power of the animal, and, consequently, as we have before seen, with the size of the body. In the pelagic Decapods, which possess the highest retro-swimming power, and whose body is comparatively large, the arms are short; while in the finless Octopods and the littoral Decapods, which have small bodies, and are consequently bad swimmers, and whose habits require the means of creeping along the ground, the arms are infinitely larger, and the connecting web is broader, so that they serve also for reptation.

The arms, to adapt them more perfectly for prehensile purposes, are provided with suckers placed *in serie*, on the inner surface. These are sometimes simple, i. e. *unarmed;* but in some genera they are surrounded by a horny dentated hoop, and in others are *uncinated*, or armed with sharp, horny hooks. When the prey is once seized by this formidable apparatus, escape is hopeless. In the tetrabranchiate Cephalopod, which is always attached to a dense calcareous shell, and whose principal food appears to be the crustacea or testacea living at the bottom of the sea, the complicated mechanism of the arms entirely disappears, and the animal is provided with numerous, small, retractile tentacles, by which the sense of touch, as necessary to it as enlarged vision is to the dibranchiate Cephalopod, is largely developed.

The presence of the sucker bearing arms, or of the tentacula, is an ordinal distinction, and has been adopted by the French naturalists for the designation of the two orders, corresponding with the dibranchiate and tetrabranchiate orders of Professor Owen, into which they have divided the Cephalopods; the armed and unarmed conditions of the suckers are also used as subordinal and generic distinctions, and characters of families and genera are founded upon the retractile power of the tentacular arms.

Exclusive of the impulsion derived from the funnel, and the capacity to rise and float in the sea which the chambered and siphoniferous shell affords, the tetrabranchiate Cephalopod can only creep, like the gasteropods, along the bottom of the sea by means of the free and expanded margin of the anterior extremity of the body.

The animal whose zoological peculiarities have been thus cursorily noticed, is sometimes lodged in a symmetrical shell, *unilocular* or *camerated* (multilocular), that is, presenting a series of chambers divided from each other by thin partitions (*septa*), and successively added by the animal to meet the exigencies of its increasing bulk, and in the last of which the body is contained. The partitions present the greatest variety of form; being in fact moulded upon the animal, they indicate corresponding zoological peculiarities, and generic distinctions have been founded upon them. Among the *Nautilidæ*, one of the families into which the tetrabranchiate Cephalopods are divided, the posterior extremity of the body is round and without any projecting part, or *lobe* as it is termed, and the septa therefore are characterised by simple curvatures or undulations, and their margins are always entire; and thus we are led by analogy to believe, that in the *Clymenidæ* the animal had an angular lobe on each side of the body, from which the sinus, which characterizes their septa, would take its form; and that in the *Ammonitidæ* the posterior extremity of the body had many lobes, the edges of which were foliated, whence the septa assumed corresponding curvatures with foliated margins. Sometimes, and this is most generally the case among the recent Cephalopods, the animal is without the protection of an external shell; but it is then supplied either with a calcareous chambered shell almost wholly buried in the animal, or with a horny or calcareous substance, simple, or more or less complicated in form and structure, wholly internal, and encysted in the back of the mantle. From the presence or absence of the external shell, the Cephalopods have been, and in fact still are, popularly divided into shell-bearing and naked Cephalopods, although in the systematic arrangement proposed by Professor Owen these terms have a more restricted application.

The chambered shells are characterised by a peculiar apparatus, by means of which, as it has been generally supposed, they are made subservient to hydrostatic purposes, although the precise mode by which that end is attained is merely conjectural. From Professor Owen's description of the *Nautilus Pompilius*, it appears that the posterior part of the visceral sac is prolonged in the form of a membranous tube, which, passing through a short calcareous collar, formed in the disc of each septum, and called the *testaceous siphon*, traverses the different chambers to the extreme nucleus of the shell. This tube, with the calcareous collar which, more or less, covers and protects it, is termed the *siphon* or *siphuncle*, and is found in all the multilocular shells strictly so called, whether external or internal, recent or fossil; and its position with reference to the margin of the shell, is used as another distinction between the *Ammonitidæ*, the *Clymenidæ*, and the *Nautilidæ*; being ventral or external, that is, placed near the outer margin, in the Ammonitidæ; central, that is, at or near the middle of the disc of the septum, in the *Nautilidæ*; and dorsal, that is, close to the preceding volution, in the *Clymenidæ*.

The process by which the external shells of the Cephalopods are constructed does not appear to differ essentially from that used by the inferior molluscs. Professor Owen has described the mode of growth in the *Nautilus Pompilius*; and we are led by analogy to the conclusion, that the shells of the extinct *Nautili* and the *Ammonites*, and their various cognate genera, were formed in the same way. In the recent

Nautilus the animal is attached to the shell by two large lateral muscles, called the *adherent* muscles, and by a belt or *cincture* of horny matter, which completely encircles the posterior part of the visceral sac, and expands at the sides into broad discs, which serve as the medium of insertion of the adherent muscles ; and the prolonged posterior extremity of the visceral sac, forming the membranous siphuncle, is a third mode of attachment. As the animal increases in size, the adherent muscles and the cincture gradually advance their line of attachment, and the membranous tube at the same time lengthening in proportion, a cavity is thus formed between the septum and the lower portion of the visceral sac. A deposition of calcareous matter by the surface of the mantle then takes place, commencing at the sides of the shell, and proceeding towards the membranous tube, round which it is continued backward, and forms the *calcareous* or *testaceous* siphon. Thus, as the animal increases in bulk, the dwelling-chambers are successively formed and converted into air-chambers, by means of which the specific gravity of the shell and its contents is maintained nearly in equilibrio with that of the surrounding water. During the growth of the animal the anterior portion of the mantle secretes calcareous matter, which it deposits in successive layers on the margin of the aperture ; and thus the enlargement of the outer wall of the shell is effected. I must add, that the theory of the gradual advance of the adherent muscles and the cincture during the growth of the animal is opposed to the opinion of M. d'Orbigny, who, in his hypothesis as to the function of the siphuncle, noticed subsequently, maintains in effect, that the advance of the muscles (and, I presume, of the cincture also) is periodic.

The Argonaut presents an extraordinary deviation from the general laws which govern all other molluscous animals ; inasmuch as the animal, although perfectly free and unattached to the shell it inhabits, is not now considered to be a mere parasite,*

* It is foreign to the present purpose to enter into the question as to the parasitism of the *Ocythoe ;* the experiments of Madame Jeannette Power, confirmed to a great extent by the observations of M. Sander Rang and M. d'Orbigny, and more recently by those of Mr. Adams, during the voyage of H.M.S. Samarang, are generally considered as removing all doubt as to that animal being the fabricator of the shell in which it is found ; and the theory of parasitism is now rejected by nearly all naturalists. A detailed account of the facts ascertained and recorded by Madame Power and M. Rang will be found in M. Rang's Mémoire, published in Guerin's 'Magasin de Zoologie,' and in Madame Power's 'Observations on the Poulpe of the Argonaut,' translations of which are published in the 'Mag. Nat. Hist.,' new series, vols. iii and iv. The observations of Mr. Adams, published in the 'Zoology of the Voyage of the Samarang,' tend to prove that the shell is constructed by the female Argonaut as a nest for receiving her eggs, and protecting them from injury, resembling in some measure the rudimental capsules secreted by many marine Gastropods for the preservation of the embryo. The animal firmly retains possession of this light calcareous shell-nest by means of the broad expanded membranes of the posterior pair of tentacles ; but when disturbed or captured, she loosens her hold, and leaving her cradle to its fate, swims about independent of her shell. Having once deserted the nest, it appears that she has not the power, or more properly the sagacity, to re-enter it. Numbers of male Argonauts were taken by Mr. Adams, but always without shells. There are, however, in this theory, difficulties which probably future observation may explain. In the first place, the shells

as at first was supposed to be the case, but the actual fabricator of the shell; and it is believed that the broad membranes usually termed *vela* or *velamenta*, into which the extremities of the posterior pair of arms are expanded, and which usually envelope the shell, are the organs by which the deposition is effected; the mantle itself, apparently, not being capable of a calcifying secretion.

The beaks or *mandibles* with which the mouths of the Cephalopods are armed, vary in structure according to the habits of the animal. In the dibranchiate Cephalopod, whose principal food consists of fish, the mandibles are sharp, and entirely composed of horn; but, with the tetrabranchiate Cephalopods, the mandibles are blunt, and cased at their extremities with hard calcareous matter, adapted for the crushing of shells, and the defensive coverings of crustacea. The fossil substances called *Rhyncolites*, resembling the mandibles of the recent *Nautilus*, and found associated with the numerous chambered shells so abundant in the secondary and transition formations, appear to be remains of Ammonites, and the other cognate extinct genera by which those shells were inhabited.*

That the external chambered shells of the Cephalopods act in the same way as the swimming bladders of fish, and serve as floats, is obvious from the circumstance that, when deserted by the animal, they swim on the surface of the water. To an animal seeking protection against its enemies, by an instantaneous sinking in the sea, this tendency of the shell to float would prove a serious and dangerous impediment, if the animal itself did not possess the means, in some way or other, of increasing on the instant its specific gravity; and it has long been the opinion of naturalists that the siphuncle is subservient to this purpose, although a difference of opinion has prevailed as to the mode of operation. Dr. Hooke, so far back as the beginning of the last century, expressed an opinion that the *Nautilus* had the power of generating air to fill the deserted chambers, and that by the injection or exhaustion of this air through the siphuncle, the specific gravity of the shell could be diminished or increased. It is ascertained, however, that there is not any communication between the siphuncle and the empty chambers; and Mr. Parkinson, who, in his 'Outlines of Oryctology,' adopts an hypothesis similar to Dr. Hooke's, suggests that the tube is elastic and dilated by gaseous or aqueous fluids, the alternation of which produces a corresponding change in the specific gravity of the shell. Dr. Buckland

are found in different stages of growth, and they always exhibit the usual indications of successive periodic enlargements. Again, Mr. Adams states, "that it does not appear that the female is able to exist long when disengaged from the shell." How can these facts be reconciled with the theory that the shell is a mere *nidus?*

* MM. de Blainville and d'Orbigny have founded on these remains two genera, which they have named *Conchorhyncus* and *Rhyncoteuthis*. The reasons advanced for supposing that the *Rhyncolites* were not the mandibles of any of the Nautilidæ or Ammonitidæ already known, are far from conclusive; and these genera can only be regarded as arbitrary, though perhaps convenient, divisions, according to the peculiar forms presented by the remains.

maintains that a fluid is contained in the *pericardium,* the position of which is alternately changed from that cavity to the siphuncle; and that in this shifting fluid the hydraulic balance consists, the chambers being filled with air alone, the elasticity of which would admit of the alternate expansion and contraction of the membranous siphuncle. Prof. Owen has pointed out objections to both these hypotheses. The only organ apparently by which the gaseous fluids of Mr. Parkinson's theory can be secreted, is a small artery continued down the siphon, but which would not be adequate for the purpose; and the form and size of the siphon would not allow of an escape of gas so free as to make the consequent sinking of the shell sufficiently rapid for defensive purposes. In some extinct species of *Nautilus* the membranous siphuncle appears to have been capable of considerable dilatation, instances of which are mentioned by Dr. Buckland; but Professor Owen states that, in all the specimens he had examined, the membranous siphuncle, after the first chamber, presented an inextensible and almost friable texture, and was coated beyond the extremity of the testaceous siphon with a thin calcareous deposit; and that, in certain extinct species, the testaceous or calcareous siphon extended from septum to septum, rendering a dilatation of the membranous tube physically impossible. The calcareous siphon of the recent Spirula, as is well known, exhibits this form of structure. It is ascertained that, by the conversion of the dwelling-chambers of the animal into what may be termed air-chambers, the specific gravity of the Nautilus, and of its shell, may be maintained nearly in equilibrio with that of the sea. This equilibrium would be very sensibly affected by the position of the body of the animal with reference to the shell; and Professor Owen therefore inclines to the opinion* that the variation of the specific gravity is caused chiefly by changes in the extent of the surface exposed to the water, according as the body may be expanded beyond the aperture of the shell, or more or less withdrawn within the dwelling-chamber. At the same time it is not improbable that the siphuncle, filled with the fluid propelled into it from the pericardium, in consequence of the pressure caused by the contraction of the animal within the shell, may assist in affecting the specific gravity; it certainly, however, does not appear to be capable of varying the specific gravity of the shell sufficiently for the wants of the animal, and that function, if attributable to it, must consequently be merely secondary. I am therefore inclined to agree with M. d'Orbigny, who rejects the supposition that the action of the siphuncle is hydrostatic. That naturalist assigns to the membranous tube which enters the calcareous siphon, and communicates with the pericardial cavity, a function widely different, and only to be called into action when the animal constructs a new air-chamber. "On this occasion," he says, "many difficulties have to be overcome; the extremity of the body is attached above the last

* In this opinion M. de Blainville concurs (Mémoire sur l'Animal de la Spirula, &c.), and he shows that a similar mode is used by the Spirula; the alteration of the specific gravity being effected by the withdrawal of the cephalic mass into a cavity formed by the upper portion of the body.

septum (*en dessus de la dernière cloison*) by two powerful muscles; and the animal, always increasing in bulk, must detach its body, and remove and place itself at a determinate distance whenever it wishes to form a new partition. There must also be left, between the penultimate partition and that which the animal is about to construct, a space to be filled with air, while the animal is always under water." And M. d'Orbigny therefore suggests "that the membranous tube and pericardial cavity are required, when the new chamber is constructed, to empty the water contained in it, and to fill it with air before the siphon entirely closes its wall in the interior of the new air-chamber." This hypothesis does not appear to be more satisfactory than the one involving a hydrostatic function. No allusion is made in any way to the attachment of the animal to the shell by means of the *horny* or *epithelial cincture* which, as we have seen, encircles the lower part of the body. This cincture, in fact, hermetically closes the space between it and the last septum; and, unless it is detached, there would not be any external entrance through which the water could penetrate, and the function, the object of the hypothesis, becomes unnecessary. I cannot think therefore that this important attachment was overlooked; and I assume that M. d'Orbigny, when he says that the animal "must detach its body," means that it must detach not only the adherent muscles which he mentions, but also the horny cincture, to which he does not allude. Conceding this to be the case, then, the hypothesis in question assumes that the advance of the body, preparatory to the formation of the new partition, is not gradual; but that the animal, by sudden and nearly simultaneous efforts, detaches the adherent muscles and the cincture, and removes its body to the necessary distance. In all other testaceous molluscs, the advance of the adductor and adherent muscles is caused by the deposition of new matter, by means of a thin membrane, part of the pallial membrane, interposed between the extremity of the muscle and the inner surface of the shell. The deposition is made, particle by particle, on the anterior part of the muscle, portions of the posterior part probably becoming detached and absorbed; but this process is so gradual, that the attachment of the animal to the shell—an attachment, in fact, necessary to its existence—is not affected; and thus the muscle advances slowly and imperceptibly. There does not appear to be any reason for supposing that a law prevails among the cephalopodous molluscs different from that which regulates the advance of the adherent muscle in the testaceous gasteropod. We may readily conceive, on the contrary, that the entire detachment of the muscles and of the cincture would be attended with considerable inconvenience to the animal; for, in that condition, the fulcrum or resisting power by which the animal is enabled to use its tentacles and other organs efficiently, and which is essential to its existence, would be temporarily lost. The sudden removal of the body forward would probably, although it cannot be assumed that it would necessarily, cause the rupture of the membranous siphon, for that organ may be sufficiently elastic to stretch to the required distance; but the rupture is, in fact, required by the hypothesis, and the animal would thus be deprived at once of all its means of attachment to the shell. Neither by this periodic advance would the equilibrium of the specific gravity be maintained. We are warranted, I think, in assuming that the specific gravity of the animal and its shell, without the siphuncular aid, would be most nearly in equilibrio with that of the surrounding sea immediately after the formation of a new septum. Now the growth of the animal would constantly tend to derange this equilibrium, until the period should arrive for the formation of the new septum. The capability of the animal, therefore, to rise and sink would be as constantly fluctuating, unless there existed some mode of compensating for the increasing bulk of the body during the interval between the formation of the penultimate septum and that of the last. This compensation, however, would be provided in the case of a gradual advance of the line of attachment; for the vacated part of the dwelling-chamber, filled with exhalations from the animal, and increasing in size as the body is advanced, would become an air-chamber as effective as if it were inclosed by a new septum; while, on the other hand, a periodic advance of the muscles and cincture would deprive the animal of this mode of maintaining the equilibrium.

I have mentioned the rupture of the membranous tube, which would be the consequence of the sudden advance of the body; in fact, the hypothesis which attributes to this tube the function of carrying off the water admitted into the vacated part of the shell by the detachment of the cincture, requires, *ex necessitate*, that the tube should be ruptured in order that the water should enter it; and in that case the membranous siphon in the deserted chambers would consist of detached fragments extending from septum to septum, and which, having fulfilled their object and become severed from the animal, would no longer retain vitality. This, however, is not the fact. The membranous tube is continued entire through all the septa to the extreme air-chamber,* and is a vascular organized substance, provided with an artery and a vein for its nutrition; and it maintains its vitality during the life of the animal. We are compelled, therefore, to think that the function of the siphuncle must be coextensive with the animal's existence. On these grounds, the theory suggested by M. d'Orbigny is not more satisfactory than the hydrostatic theory which he rejects. Whatever the function may be, it is evident that the air-chambers themselves would be as efficient a float without the siphon as with it; and the alteration of the specific gravity, as has been stated, may and in all probability is, effected simply by the animal protruding or withdrawing the cephalic mass from or into the dwelling-chamber of the shell, or, as

* Professor Owen, speaking of the specimen of *Spirula Peronii* (*fragilis*), brought home by Sir Edward Belcher, says: "On gently raising the exposed portion of the siphon with a needle, the soft siphon was withdrawn, without sensible resistance, from the tube of the hard siphon; the siphon so withdrawn must have reached nearly to the innermost whorl. It exhibited a slight segmentation, answering to the successively sheathed parts of the calcareous siphon."

M. de Blainville has shown to be the case in Spirula, within a cavity formed by the anterior extremity of the mantle. We may reasonably infer, therefore, that to assist in varying the specific gravity is not the principal function of the siphuncle. But, in any view, the preservation of the deserted chambers, as air-chambers, is essential to the motive power of the animal; for it is only by their tendency to float when the cephalic mass is protruded, that the animal is enabled to rise; and this nicely-adjusted counterpoise is maintained, as we have seen, by the addition of new air-chambers, as the animal and the shell increase in size. It is obvious, therefore, that the hydrostatic balance would be destroyed if any one of the deserted chambers were so injured as no longer to act as a float. Now it is known that the shells of the testaceous molluscs are not wholly inorganic substances; but that a vital communication is maintained between them and the animals, and that where this communication ceases, the deserted whorls of the shell lose their vitality and become brittle; the calcareous matter falls off in particles, and the shell is much more susceptible of injury. In *Bulimus decollatus* (*Helix decollata*, Linn.) and other similar shells, in which the earlier whorls are wholly deserted, the animal on withdrawing its body forms behind its extremity a concave septum. In these cases the apex of the shell, no longer necessary, is easily broken off; in which state the shell is said to be *decollated*.* In the siphoniferous shells, however, the preservation of the chambers, as air-chambers, is, as we have already seen, essential to the motive power of the animal. It is true that in the Nautilus, the mode of convolution, upon a vertical axis, is admirably adapted to strengthen and protect the first-formed volutions; but in shells not so constructed, and even in those possessing the nautiliform mode of convolution, it would appear to be essential that the vitality should not be lost. How, then, is the necessary communication between the animal and the air-chambers maintained, and the vitality of the deserted shell preserved? It has been shown that the siphuncle traverses the chambers to the extreme nucleus of the shell, and that it is provided with a small artery and vein; and we also learn from Professor Owen's Memoir, that in the Nautilus "a delicate pellicle, distinct from the tube, is continued over the outer part of the testaceous tube, and also over the whole inner surface of the chamber." May we not then reasonably regard the siphuncle with its artery and vein, and the pellicle lining the air-chambers, as the organs destined to maintain the vitality of the shell, and feel ourselves justified in considering this office to be in fact the primary function of the siphuncle? And when we bear in mind that the internal shells, from

* I am wholly indebted to my friend Mr. Searles Wood for the following theory as to the siphuncular function, and the main arguments in support of it. The well-known conchological attainments of that gentleman exact respect for every opinion of his on subjects like the present; but independently of this, the theory itself seems to me to be far more probable than any hitherto advanced as to the office of the siphon; and I therefore gladly avail myself of Mr. Wood's permission to introduce his views of the subject into my text.

their terminal or, as in Spirula, their exposed position, are particularly liable to injury from the shocks caused by the retrogressive movements of the animals, we shall find that the hypothesis will be as applicable to them as to the external shells. In the extended series of observations made by Dr. Carpenter upon the microscopic structure of shells, it is shown by that gentleman that the outer covering or shelly mass of molluscous animals is invariably permeated by an organized membrane, and he says (Report Brit. Assoc., 1844, page 9): "I am much disposed to believe that in every distinct formation of shell substance there is a single layer of membrane, and I am further of opinion that this membrane was at one time a constituent part of the mantle of the mollusc." He further represents this membrane to have, more or less, a cellular arrangement, the interstices of which are filled with carbonate of lime or inorganic matter; and, at page 10, he says: "Coupling the appearances which I have myself observed, with the observations of Mr. Bowerbank, on the formation of shell, and keeping in view the general doctrines of cell action which I have elsewhere endeavoured to develope, I am inclined to believe that these cells are the real agents in the production of the shell, it being their office to secrete into their own cavities the carbonate of lime supplied by the fluids of the animal." He does not appear to have extended his researches so far as to determine whether any or what amount of vitality is possessed by these membranes; but from the continuity and intimate connexion of this beautiful network, permeating the entire substance of the shell, we may imagine that some slight degree of vital existence pervades the whole membrane, by which it is possible that the inorganic material is preserved from disintegration. In those shells which appear to have been subject to the erosive action of acidulated waters, or other external agency, such as the apices of *Cerithia* and the umbones of *Cyrenæ*, the part most affected is that which is furthest removed from the main body of the animal; while that part of the shell which is in close proximity with the mantle is not, or at least but little, altered; probably owing to its greater vitality, and to its being the part most essential for the protection of the animal. Not only is the entire formation of shelly matter permeated by an organic membrane, but in some of the shelly coverings of molluscous animals in the order *Brachiopoda*, there is a very peculiar structure, somewhat analogous with what has been before suggested as the especial use of the siphuncular tube in the Cephalopoda. Dr. Carpenter has pointed out that in most, or perhaps in all, of the nonplicated species of Terebratula, the whole surface of the shell is perforated with innumerable pores, into which are inserted vascular portions of the mantle of the animal, of a tubular form, and filled with fluid, which have no communication with the exterior, but are closed at the outer surface of the shell, and occupy the entire space of the pores. These cæcal appendages may be for the purpose of distributing a greater degree of vitality through the body of the shell; though for what especial purpose this provision is required in one group more than another, it is not easy to explain; perhaps a greater degree of strength is required in the *nonplicated* shell, for the preservation of an animal, whose habitation, for the most part, is at a considerable depth, where the pressure of water is much increased, than in the plicated species, the peculiar construction of which would afford sufficient resistance, without that additional support which the smoother species may receive from this singular structure of the mantle. If, however, a necessity exist for the preservation of the shell in ordinary cases, how much more essential would it be that some compensating power should be possessed by an animal whose existence, in all probability, is dependent upon the buoyant principle of its partitioned shell; and how probable does it appear that this, an ordinary provision, should be employed for its protection.

The tubular character of the siphuncle suggests an hydraulic action. To explain this, it is necessary to invest the animal with the power of emptying and filling the tube at discretion; and this power it may be presumed to derive from the pressure upon the pericardial cavity, caused by the folding and contracting within the shell of the large cephalic mass. Under this pressure the fluid would be injected the whole length of the siphuncle, and, on the removal of the pressure, would return into the pericardium, to be there renovated and vivified with the other fluids, to be again injected when the animal returns within the shell. If the siphuncle had been a solid body, or composed of muscles, fibres, &c., it would have required to be permeated with arteries, blood-vessels, &c., for its sustenance; but by the simple process of the fluid returning into the body of the animal, all the complicated apparatus necessary to sustain a fleshy body is superseded; circulation and renovation are accomplished, and the fluid is thus maintained in a condition capable of affording the nourishment to the shell which the present hypothesis requires.

The theories here suggested are, as all other theories on the same subject must for the present be, merely speculative; for, to quote the observation of Professor Owen,* "much remains to be done before the theory of the chambers and siphuncle can rest on the sound basis of experiment and observation." These alone will satisfactorily determine the real purposes of the membranous siphuncle; but, for my own part, I believe that the primary, and probably the only, function of that organ is to maintain the vitality of the shell, and that it may be looked upon as an elongated cæcum; and that it is not, under any circumstances, used by the animal as a hydrostatic balance.

It is unnecessary here to particularise the various forms of external shells presented by the extinct tetrabranchiate Cephalopods, inasmuch as, of the numerous genera which swarmed in the ancient seas, only the Nautilus survived the secondary period.

The dibranchiate Cephalopods, with the exception of the genus *Argonauta* (which, with *Bellerophon*, constitutes Professor Owen's family of testaceous Octopods), are without

* Memoir on the Nautilus Pompilius, p. 47.

external shells; but they are provided with internal horny or calcareous substances, encysted in the back of the mantle, and frequently not in any way attached to the animal, but loose in the cells containing them. In the naked Octopods these internal substances are of the simplest form, and consist of two short, horny, gelatinous styles. Among the Decapods, they become gradually more complicated in structure. In the *Loligidæ*, the *Loligopsidæ*, and the *Teuthidæ*, they assume the form of a horny plate, termed the *gladius*, which in some genera is thin and feather-shaped, or more or less spatulate, lanceolate, or ensiform; and in others, they are elongated, narrow, and terminated posteriorily by a simple cup-shaped appendage. In the *Sepidæ* the shell presents a series of thin calcareous plates, not siphoniferous, but separated by numerous exceedingly minute pillars, and forming a convex mass terminated by a *mucro* or spine; in the *Belemnitidæ* it consists of a chambered cone perforated by a siphuncle, and lodged in a cavity formed in the upper portion of a calcareous rostrum, more or less pointed or obtuse; and in the *Spirulidæ*, the sole remaining family, it is a calcareous, horizontally convolute, multilocular, and siphonated shell, with distinct whorls, and imbedded in the animal, but having portions of the last whorl merely covered by the outer layers of the skin. These differences in structure appear to be always accompanied with distinct zoological forms; and hence the Palæontologist is enabled to form a tolerably correct judgment of the analogy between the existing species and those which inhabited the ancient seas, although the testaceous remains are, most frequently, the only means of comparison afforded to him.

These internal shells are formed by secretions, from the internal surfaces of the cells, of a horny or calcareous substance, which is deposited in successive layers, and by the continual addition of which they increase in size as the growth of the animal proceeds. Their functions are various, and in accordance with their particular structure. When the internal shell is gelatinous or horny, as in the Octopoda, and in the *Loligidæ*, *Loligopsidæ*, and *Teuthidæ*, the function is chiefly to support and strengthen the body, analogous with that of the bones in the vertebrate animals. It appears that the greater or less length of the shell has always relation to the swimming power of the animal. When the internal shell is horny or calcareous, and contains parts filled with air, as is the case in the several other decapodous families, it acts as a float; and in this function, like the external shell of the tetrabranchiate Cephalopods, it represents the swimming bladder of fish; but the volume of air contained within the shell is, apparently, in an inverse ratio with the swimming power of the animal. In addition to these functions, the internal shells, which are provided with a mucro or rostrum at their posterior extremities, as in the *Sepidæ* and *Belemnitidæ*, are enabled by its means to break the force of the shocks caused by the body striking against any hard substance in its retrograde motion. In the recent Cephalopods this protection is confined to the *Sepidæ*, the most littoral of all the Cephalopods: to the deep-sea swimmers it is denied; it would in fact be useless to them. We may assume, therefore, that in the extinct Cephalopods the presence of the mucro or rostrum will indicate a littoral animal. M. d'Orbigny states that he has always observed in the Sepia, the extremity of the mucro projecting beyond the body, and it is not improbable that this part of the shell may be used, as he suggests, for defensive purposes, and that it is protruded at the will of the animal.

The Cephalopods, highly organized as they are in comparison with the other molluscs, are among the earliest forms of animal life which geology has brought to light. The Silurian group, the most ancient fossiliferous formations with which we are acquainted, contains the remains of one species of Nautilus, and of many species belonging to cognate genera. Several species of Goniatites, an anomalous genus belonging to the *Ammonitidæ,* and connecting that family with the *Nautilidæ,* also occur. As we ascend in the Palæozoic series, we find that various of the primitive genera and species disappear, and are succeeded by other forms, distinct from, although closely allied to, them; which, in their turn, are also lost. On passing into the Mesozoic series a marked change takes place. Of the eight genera constituting the family *Nautilidæ,* which lived during the Palæozoic epoch, Orthoceras* and Nautilus alone survive; and of the long series of species belonging to the latter genus, whose remains are found in the carboniferous formations, every one disappears; but an immense array of Ammonites starts into existence, with septa at first comparatively simple, but becoming more complicated in structure in the succeeding formations. The dibranchiate Cephalopods now first appear.† In the Oolitic group, twenty-five species of Belemnite, and remains of various genera belonging to the families *Loligidæ* and *Teuthidæ,* have been found. The Belemnites occur in incredible quantities, and sometimes form entire strata. Passing into the Cretaceous group, we still find the Nautilus, though of diminished importance; the Ammonites are reduced in number to little more than a fourth part of the species found in the Oolitic group, and new modes of convolution appear in their shells, on which the several other genera constituting the family *Ammonitidæ* are founded. The family itself gradually diminishes as we ascend in the Cretaceous group, and wholly disappears with the secondary period. The Belemnites appear to be the sole representatives of the dibranchiate Cephalopods during this epoch, and with it they also perish. On entering into the tertiary formations we find, that of the rich and varied assemblage of tetrabranchiate Cephalopods which characterised the fauna of the secondary period, only the *Nautili* survived. On the Continent their remains are found in the Eocene formations, and also in the Miocene formations, at Turin and in Touraine; but in this country they are confined to the older Eocene deposits. Of

* Von Hauer (Neue Cephalopoden aus dem rothen Marmor von Aussee), describes several Orthoceratites associated with Goniatites in the schistose beds of St. Cassian; those beds, I believe, are now generally considered to belong to the Muschelkalk.

† The remains described by Goldfuss and Bronn as *Spirulæ,* appear to belong to Gyroceras, a genus of the *Nautilidæ.*

the dibranchiate Cephalopods, two species of Argonaut have been found in the newer tertiary formations on the Continent; and two genera belonging to the family *Belemnitidæ* occur in the beds of the Paris basin, and in the Eocene formations of England. The remains of one of these last are very closely allied to the recent Sepia, and have been generally referred to that genus. M. Voltz, in his 'Observations sur les Bélemnites,' pointed out certain differences which induced him to propose a new genus, named by him "Belosepia," for their reception. The French Palæontologists reject this genus as having been proposed on insufficient grounds; but, for the reasons stated in a subsequent part, it ought, as it appears to me, to be retained. The other remains found in the Paris basin, connect Belosepia with Belemnite; and the genus *Beloptera* has been established by M. Deshayes for their reception. Both these genera occur in the London clay and in the Bracklesham sands; and they, together with certain remains found in the neighbourhood of London, and described by Mr. James Sowerby in the Mineral Conchology as *Beloptera anomala*, and for the reception of which I have proposed the new genus *Belemnosis*, are the only remains of dibranchiate Cephalopods which as yet have been found in the tertiary formations of England.

That these animals fulfilled in the ancient seas the office of repressing animal life cannot be doubted. The living Cephalopods are voracious in the extreme; and, as we find that throughout the transition and secondary groups the number of the zoophagous Trachelipods is small in comparison with that of the phytophagous Mollusca, it is not unreasonable to seek in the Cephalopods for that check upon an excessive increase of submarine life, which the other zoophagous molluscs were too inconsiderable in number to afford.*

There is scarcely any class in the animal kingdom of the anatomy and habits of which zoologists have so long remained ignorant, or of which the systematic arrangements proposed have been so conflicting as the class Cephalopoda. Composed, as it is, of animals in their external construction and appearance remote from all others, and widely differing among themselves, we need not feel surprised at the confusion which characterises the older systems, based, as they all were, more or less, on artificial characters, derived from the various conditions of the shell, or from modifications of the dermal system; and the confusion was increased by the introduction among the Cephalopods of numerous microscopic chambered shells, to which M. d'Orbigny gave the name *Foraminifera*, but which the recent investigations of Dujardin show to have been constructed by an inferior class of animals, belonging or allied to the Zoophyta, and which he has named *Rhizopoda*. It would be foreign to the purpose to enter here into any history or comparison of the different systems of arrangement which have been proposed. In the eleventh volume of Lamarck's 'Histoire Naturelle des animaux sans vertèbres,' edited by MM. Deshayes and Milne Edwards the reader

* See Dr. Buckland's Bridgewater Treatise, vol. i, chap. xv.

will find a most comprehensive and able review of the progress of this branch of natural history.

The principle of classification adopted by Cuvier removed many of the difficulties and inconsistencies which had previously prevailed; but it was still based, to a great extent, on external characters. Attempts at arrangements, founded on higher characters, were made by different authors; but the imperfect knowledge which existed of the anatomy of the animals, prevented the establishment of a system in which due regard could be paid to affinities indicated by internal organization. Of late years, however, considerable additions have been made to our knowledge of the anatomy of these animals; and in 1830, the arrival in this country of a specimen of the pearly Nautilus, caught off the coast of one of the New Hebrides, enabled Professor Owen to examine the internal structure of that animal, an opportunity which had not occurred to naturalists since the time of Rumphius. The anatomy of various other Cephalopods was also investigated by Professor Owen; and the additional information thus obtained, led that gentleman, in 1836, to propose a system of classification which, although at variance in many respects with all previous arrangements, was at once received as one founded, in its general principles, on well-defined and natural characters; and this system, accordingly, forms the basis of the more recent classifications.*

All the Cephalopods the anatomy of which had been examined previously to the arrival of the pearly Nautilus, respired by the agency of two branchiæ or gills, and possessed three hearts, a systemic heart, and two lateral hearts; they were also endowed with eight arms furnished with suckers, some genera having also two elongated tentacula or additional arms. The pearly Nautilus, however, was found to be possessed of four branchiæ, and of only one heart; and, instead of arms, the mouth of the animal was surrounded by numerous short tentacula. Availing himself of these natural and well-defined characters, Professor Owen divided the Cephalopoda into two orders: 1st, *Dibranchiata*, comprising those furnished with two gills; and 2d, *Tetrabranchiata*, comprising those furnished with four gills. The Dibranchiata were subdivided into two sub-orders or tribes, according to the number and condition of their locomotive organs; the first tribe (Octopoda) consisting of the Cephalopods with eight arms, having the suckers simple, and the branchial chamber divided by a diaphragm; the second tribe (Decapoda) consisting of those Cephalopods possessed

* Up to this time Spirula, as well as Belemnites, had been classed with Nautilus, and the other Cephalopods which now form the tetrabranchiate order (*Ceph. test. polythalamaces* of Lam.; *Siphonifères* of D'Orb.) Of the anatomy of the animal nothing was known; but the presence of an ink-bag, and the acetabuliferous character of the arms had been shown by Lamarck and Peron; and from this fact Professor Owen, aided by that knowledge of the laws of correlation which imparts such value to all his observations, inferred that the animal must present the dibranchiate type of structure. The accuracy of this deduction is now fully established.

of eight arms, and two additional elongated tentacula. In this tribe the suckers are armed, and the mantle supports two lateral or terminal fins. The "*Octopoda*" were divided into two families, termed "*Nuda*" and "*Testacea*," according to the absence or presence of an external shell. In the second family was placed *Bellerophon*, an extinct genus proposed by De Montfort for remains peculiar to the Palæozoic series, which Defrance had associated with Argonaut, but which subsequently had been considered as belonging to a heteropodous mollusc. The reasons which induced Professor Owen to restore *Bellerophon* to a place among the Cephalopods are not stated. If however, its remains belong to this class, they present the anomaly of the testaceous Octopods having been without a representative from the end of the carboniferous epoch until the deposit of the newer tertiary formations, when the family reappears in the genus Argonaut. The decapodous Cephalopods were divided into four families, according to the position of the fins, the nature of the internal shell, and the condition of the infundibular cartilage. The ordinal and sub-ordinal distinctions of Professor Owen have been adopted by M. Deshayes, but that naturalist has subdivided the Octopoda and Decapoda each into two groups; the Octopoda according to their possessing one or two rows of suckers, and the Decapoda according to the position of the fins. These characters appear to be of secondary importance, and, by themselves, can scarcely be considered as sufficient for more than generic distinctions. M. d'Orbigny has availed himself of the presence of suckers and tentacles, characters originally proposed by himself and M. Ferussac as ordinal distinctions, and accordingly the Cephalopoda are divided by him into *Acetabulifera* and *Tentaculifera*. The sub-ordinal distinctions of Professor Owen are adopted by this author; but in his subdivision of Octopoda he has drawn his characters from the presence or absence of the apparatus for resistance, and the aquiferous pores. The Decapoda are arranged by him in two groups, according to the modification in the structure of their eyes, to which I have before alluded. The first group (*Myopsidæ*) is divided into three families. In two of these, *Sepidæ* and *Loligidæ*, the characters are taken from the retractile power of the tentacular arms, the condition of the internal shell, and the presence or absence of an eyelid of a part of the auditory apparatus called by him the auricular crests (crêtes auriculaires), and of a superior ligament to the funnel; the character of the third family (*Spirulidæ*) rests entirely on the internal shell. The second group (*Oigopsidæ*) also consists of three families, two of which, *Loligopsidæ* and *Teuthidæ*, depend on the presence or absence of a lachrymal sinus and the auricular crests, on the funnel being or not being provided with an internal valve and ligaments, on the condition of the aquiferous pores, and on the shell being with or without air-chambers. The *Belemnitidæ*, the third family, is separated entirely by the character of the internal shell.

The peculiar modifications in the structure of the eyes among the decapodous Cephalopods appear to be of sufficient importance to justify the subdivision of that sub-order into the two groups proposed by M. d'Orbigny; and inasmuch as the adoption of that division involves the distribution of the genera forming Professor Owen's extensive family *Teuthidæ* between the two groups, and the characters on which M. d'Orbigny has formed his families are at the least of equal importance with those used by Professor Owen, I have adopted the classification proposed by M. d'Orbigny, but with the following modification. That author has placed *Beloptera* and *Spirulirostra* among the *Spirulidæ.* Now the shells of these genera present a series of siphonated air-chambers associated with a rostrum, and therefore bear a much closer affinity with *Belemnite* than with the shell of the recent Spirula. I have, therefore, placed them, as well as *Belemnosis,* among the *Belemnitidæ;* and as I agree with Voltz in considering *Belosepia* to have possessed a camerated and siphoniferous shell, I have also placed that genus in the same family, notwithstanding the close affinity between its remains and the internal shell of the recent Sepia.

CLASSIFICATION OF THE CEPHALOPODS.

MOLLUSCA.

CEPHALOPODA.

- Dibranchiata (Acetabulifera; *Fer. et d'Orb.*)
  - Octopoda
    - Octopidæ
      - Eledone.
      - Octopus.
      - Pinnoctopus.
      - Cirroteuthis.
    - Philonexidæ
      - Philonexis.
      - Argonauta.
  - Decapoda
    - Myopsidæ
      - Sepidæ
        - Cranchia.
        - Sepiola.
        - Sepioloidea.
        - Rossia.
        - Sepia.
      - Spirulidæ
        - Spirula.
      - Loligidæ
        - Loligo.
        - Sepioteuthis.
        - Teudopsis.
        - Leptoteuthis.
        - Beloteuthis.
    - Oigopsidæ
      - Loligopsidæ
        - Loligopsis.
        - Chiroteuthis.
        - Histioteuthis.
      - Teuthidæ
        - Onychoteuthis.
        - Enoploteuthis.
        - Kelæno (Acanthoteuthis, *Wagn.*)
        - Ommastrephia.
        - Belemnosepia *Agaz.* (Geoteuthis, *Muns.*)
      - Belemnitidæ
        - Belosepia.
        - Beloptera.
        - Belemnosis.
        - Spirulirostra.
        - Conoteuthis.
        - Belemnoteuthis.
        - Belemnitella.
        - Belemnites.
- Tetrabranchiata. (Siphonifera; *Fer. et d'Orb.* Tentaculifera; *d'Orb.*)
  - Nautilidæ
    - Nautilus.
    - Planulites (*Lam*).
    - Gyroceras.
    - Lituitus.
    - Campulites, *Desh.* (Cyrtoceras, *Goldf.*)
    - Phragmoceras.
    - Orthoceras.
    - Actinoceras.
    - Koleoceras (*Portl*).
    - Porterioceras *M'Coy* (Gomphoceras, *Sow.*)
  - Clymenidæ
    - Aturia.
    - Clymenia.
  - Ammonitidæ
    - Turrilites.
    - Helioceras.
    - Goniatites.
    - Ammonites.
    - Crioceras.
    - Scaphites.
    - Ancyloceras.
    - Hamites.
    - Toxoceras.
    - Ptychoceras.
    - Baculites.

Order—*DIBRANCHIATA.* Sub-order—*DECAPODA.*

Tribe—Oigopsidæ.

1*st Family*—Belemnitidæ.

The *Belemnitidæ*, the sixth family in the classification proposed by M. d'Orbigny, consist, according to that author, of the genera in which the animal was provided with an internal horny or calcareous shell, having at the *posterior part* air-chambers superimposed in a nearly straight line in the form of a cone, and pierced on the ventral part by a marginal syphon. The family is confined, according to that author, to the three extinct genera, *Conoteuthis*, *Belemnitella*, and *Belemnites*.

The two latter genera, however, do not appear to fall strictly within the terms of the definition; for the posterior parts of their shells consist, as is well known, of a spathose guard, frequently of considerable size, the anterior extremity of which is produced so as to form an alveolus for the reception of the phragmocone. If, as the fact is, the genus *Belemnites* forms the typical genus of the *Belemnitidæ*, it would surely be proper that those genera which, like the type, possess camerated siphoniferous shells, terminated posteriorily by a calcareous guard, should, at all events, be included in the family. It is difficult therefore to conceive on what sound principle *Spirulirostra* and *Beloptera*, but more particularly the last genus, whose calcareous remains present so striking a resemblance to those of *Belemnites*, instead of being placed in this family, have been associated with *Spirula*, with whose spiral discoidal shell they present so little analogy.

It appears to be desirable that, for the present at least, the Belemnitidæ should be extended so as to comprise all the genera in which the animal possessed an internal horny or calcareous shell, with or without a terminal guard, but containing air-chambers pierced by a ventral siphuncle; whether those chambers were superimposed in a nearly straight line in the form of a cone, or in a spiral or subspiral line. As thus enlarged, the Belemnitidæ will consist of the following genera: Belosepia, Beloptera, Belemnosis, Spirulirostra, Conoteuthis, Belemnoteuthis, Belemnitella, and Belemnites.

Hereafter it may be desirable to form a division for the reception of genera in which, as in Conoteuthis, the apex of the sheath is simple.

All attempts at a linear arrangement are absolutely futile; but it will be seen that in this, as in every case where several genera are grouped together, the family presents aberrant forms leading to other groups; thus *Beloptera*, *Belemnosis*, and *Belosepia*, leading to *Sepidæ; Belosepia* and *Spirulirostra* to *Spirulidæ;* and *Conoteuthis* to *Teuthidæ*.

Genus 1*st*. Belosepia.* *Voltz.* 1830.

Sepia. *Cuvier; Férussac; d'Orbigny; Deshayes.*
Belosepia. *Bronn.*

Animal unknown; but, from the affinities between its calcareous remains and the internal shell of the recent Sepia, supposed to have more nearly resembled that genus than any other existing Cephalopod, and may be thus described:

Body oblong, (?) naked, supporting two lateral fins extending its whole length; *mouth* terminal, furnished with two corneous mandibles, and surrounded by ten prehensile acetabuliferous arms, of which two were longer than the others; *mantle* free at the anterior margin; *branchiæ* two.

Shell internal, oblong, semiconical, coarsely granulated or sulcated on the exterior, internally smooth, containing a series of transverse laminæ, perforated near their ventral margins by large elliptical, sub-siphoniform openings, and terminating in a solid beak or rostrum, inflected towards the dorsal aspect, and expanded at the anterior extremity on the dorsal aspect into an elevated callus, and on the ventral aspect into a semicircular plate bent outwards over the base of the rostrum; the ventral margins of the laminæ converging towards the anterior extremity of the rostrum, and connected by a thin calcareous plate.

Testâ internâ, oblongâ, semiconicâ, externè granulatâ, internè lævigatâ; septa transversa, foraminibus ventralibus ellipticis subsiphonoidis perforata, continenti, et rostro solido, anticè, parte dorsali in callum proeminentem, parte ventrali in laminam supra rostrum reflexam dilatato, posticè sursum inflexo, terminatâ; septorum marginibus ventralibus ad basim rostri convergentibus et tenui laminâ connexis.

The remains of this extinct Cephalopod have been long known as of frequent occurrence in the Paris basin; they were noticed by Guettard† and were described by him as the fossil teeth of sharks. They were also figured by Burtin,‡ and by him were considered to be internal bones of a fish's head. To Cuvier palæontology is indebted for pointing out their true character. In a short notice published in 1824, in the 'Annales des Sciences Naturelles,' that illustrious naturalist referred the remains in question to a cephalopodous mollusc closely allied to the recent Sepia; and, in fact, they, as well as the remains of another extinct Cephalopod which exhibited an unquestionably camerated and siphoniferous structure, and for the reception of which the genus *Beloptera* had been established by M. Deshayes, were placed by M. d'Orbigny in that genus. M. de Blainville also in the first instance described them as the remains of a Sepia; but afterwards, when he adopted the genus Beloptera for the *Sepia*

* Etym. Βελος, telum; Σηπία, sepia.

† Mémoires sur différentes parties des Sciences et Arts, 1783, Septième Mémoire, pl. 2, figs. 29-30.

‡ Oryctyographie de Bruxelles (1784), pl. 2, fig. A.

Parisiensis, he confounded with it the remains in question. M. Voltz was the first to examine these remains with the attention they deserve. This author instituted a comparison between the shell of the *Beloptera Belemnitoidea*, that of the *Beloptera Sepioidea* (Sepia Parisiensis), and the recent *Sepion*, and stated the reasons which induced him to consider the *Beloptera Sepioidea* as belonging to a distinct genus, equally removed from the *Beloptera Belemnitoidea* and the recent *Sepia*, and as forming a natural connexion between *Belemnites* and *Sepia;* and he proposed the present genus, *Belosepia*, for its reception. The principal ground advanced by him to justify this separation was, that the remains of Belosepia indicated a camerated and siphoniferous structure in the contents of the sheath, widely different from that of the Sepion; and, if this opinion be correct, there cannot be a doubt as to the propriety of the separation. M. Deshayes, however, in his 'Description des Coquilles fossiles des Environs de Paris,' without questioning in any respect the accuracy of M. Voltz's description, without referring even to that author's opinion as to the siphoniferous structure of the shell, but simply relying on the analogy drawn from the general resemblance between the remains of the *Sepia Parisiensis* and the *Sepion*, unhesitatingly rejected the genus Belosepia as not possessing characters sufficiently distinct from those of *Sepia;* although he considered that it would be desirable to form a section in the genus Sepia for the reception of the fossil species. In this opinion M. Deshayes has been followed by MM. Pictet and d'Orbigny. I cannot concur with these authors in the rejection of M. Voltz's genus. The Belosepion* appears to me to present peculiarities of structure, indicating corresponding important zoological differences, which render it impossible to regard the animal to which it belonged as forming part of the existing genus Sepia.

The Belosepion, like the internal shell of the Sepia, is a compound shell, and consists of—1st, a solid calcareous mucro, or rostrum, commonly called *the beak*, inflected at the posterior extremity towards the dorsal aspect, and at the base expanding on the dorsal aspect into an elevated, compressed, and more or less rugose mass, called by M. Deshayes the *callus*, and on the ventral aspect into a thick semicircular plate, bent outwards, in a radiated fold, over, but not touching, the upper portion of the rostrum, denticulated on the margin, and continued laterally into the parietes of the sheath.

2d. An inverted semiconical calcareous plate, termed the *sheath*, externally coarsely granulated, internally smooth, but presenting a series of undulating impressions, converging towards the inverted apex, where the sheath terminates in a conical cavity, formed in the anterior portion of the rostrum, and strongly inflected towards the ventral aspect, so that the posterior extremity presses against the origin of the radiated fold.

* The term *Belosepion* is used here to describe the entire internal shell of the *Belosepia;* in the same way as the term *Sepion* (*Sepiostaire* of De Blainville) is used by English writers to describe the internal shell of the *Sepia*, or what is usually known as "Cuttlefish-bone."

3d. A thin calcareous layer, covering the whole of the inner surface and the terminal cavity of the sheath; and

4th. A series of thin laminæ or septa imposed one upon another, at first nearly vertically, but assuming gradually a horizontal direction, owing to the convergence, towards the origin of the radiated fold, of their ventral margins, which are nearly straight, and connected by a calcareous plate, forming the ventral surface of the sheath.

The undulating impressions which appear within the sheath are strongly defined on the dorsal aspect, but become faint as they approach the ventral surface. M. Voltz has described these undulations as impressions of the sutures of the *alveolus*;* while, on the other hand, M. d'Orbigny considers them to be lines of growth, and not marks of the chambers, which, he says, in fact only occupied one half of the cavity. They are, however, strictly analogous with the similar impressions found in the *Sepion*, and are formed by the margins of the laminæ or septa. Being formed in succession as the new laminæ are added, it is true that in that way they represent the progressive increase of the shell; but they are not true lines of growth.

The extreme fragility of the laminæ has not allowed of their preservation; but their remains occur, not unfrequently, towards the posterior extremity of the sheath, consisting of fine elevated lines, which traverse the whole circumference of the cavity, and are, in fact, the dorsal and lateral margins of the laminæ adhering to the inner sheath. These lines are continued over the calcareous plate, which connects the ventral margins of the laminæ; and it is evident, therefore, that the laminæ extended across the whole of the transverse area of the sheath.

The ventral margins are always convergent towards the origin of the radiated fold; and, consequently, the laminæ within the terminal cavity slant in a direction opposite to that of the laminæ within the sheath, inasmuch as that the cavity extends wholly below the origin of the fold. Owing to this, the arrangement of the chambers formed by the septa somewhat resembles that of the air-chambers in *Spirulirostra*, except that in the latter shell the plane of the septa is always at right angles with the axis; while in the *Belosepion* it is at an angle more or less acute as the septa approach to, or recede from, the point of convergence. In the cavity itself, the dorsal margins of the laminæ are distant; but as they approach that part of the sheath which is immediately under the point of convergence, they are placed more closely to each other, and they again become distant as the laminæ emerge from the cavity. Owing to the convergence of their ventral margins, the laminæ, which as they emerge are nearly vertical, take a direction gradually more and more slanting towards the anterior extremity of the rostrum, until, on the shell attaining its full growth, they assume a position nearly

* The word *alveolus* is used by this author in its original meaning, and is applied to the chambered cone which Professor Owen has named the *phragmocone*. The term *alveolus* has been with greater propriety restricted by the latter gentleman to the cavity in which the *phragmocone* was lodged.

horizontal. This arrangement of the laminæ is well displayed in fig. 1*h*, Tab. I, drawn from a specimen found at Sheppy, for the use of which I am indebted to Mr. Dixon, to whom it belongs. The ventral margins of the laminæ extend quite across the connecting plate before mentioned; and on each side, at a short distance from the extremities, they expand into the lateral portions of the laminæ, small projecting fragments of which are sometimes still found adhering to the sides of the sheath. It is evident from this that the opinion expressed by M. Voltz, that there existed in each of the laminæ an opening placed near the ventral margin, is correct. These openings appear to have been of an elliptical form, with their shorter axes in a line from the ventral to the dorsal surface, and were lined with an extremely thin calcareous sheath, which extended throughout the whole series of the laminæ, and of which portions are frequently found adhering to the inner edges of the ventral margins and the lateral fragments of the laminæ. This sheath corresponds with the siphon of the Belemnites, and is represented in the Sepion by the calcareous layer which, extending over the posterior edges of the laminæ, covers the entire surface of the last lamina, and it presents, as M. Voltz states, an intermediate form between the narrow, straight siphon of the Belemnites and the wide, open cavity of the Sepion.

Whether the spaces between the laminæ were filled with minute columnar partitions, similar to those which characterise the Sepion, or whether they were simple air-chambers, we have not at present any evidence to determine. The probability is, that they were simply air-chambers; for no trace whatever of any substance similar to that termed the spongioid tissue of the Sepion has been found, which, had any such substance existed, might reasonably have been expected; and the true siphonal structure, to which the Belosepion presents so close an approximation, is always associated with simple air-chambers. The Belosepion, as its rostrum indicates, belonged to a Cephalopod eminently littoral in its habits, and the size, notwithstanding the extraordinary development of the rostrum, leads us to believe that the animal was not only smaller, but a less powerful swimmer, than the recent Sepia. We should expect, therefore, to find in it some provision for buoyancy beyond that with which the recent Sepia is furnished, not only for the purpose of increasing the swimming power of the animal, but also as a compensation for the large and dense rostrum and callus which characterise its remains. But if the interlaminar spaces were filled with any substance resembling the spongioid tissue of the Sepion, the floating apparatus of the Belosepion would be apparently inadequate to the wants of the animal. The form and mode of superposition of the laminæ, somewhat resembling the arrangement of the septa in *Spirulirostra*, present a closer analogy with the phragmocone of the Belemnites than with the plates of the Sepion. These considerations give additional weight to the opinion of M. Voltz, founded on the appearance of what he terms the "alveolar sutures," that the Belosepion was a camerated and siphoniferous shell.

The rostrum of the Belosepion presents a structure analogous with that of the spathose guard of the Belemnite. It has a tendency to split in two along the centre, in a vertical plane, from the ventral to the dorsal aspect; and it is composed of successive conical layers, each enveloping the preceding layer, and exhibiting a fibrous texture crosswise. The anterior lateral and dorsal portions present straight plates, longitudinally fibrous, resembling the structure of the *Beloptera Belemnitoidea*, and the external edges hang over each other, and give an imbricated appearance to that part of the rostrum.

In order to appreciate the differences which appear to render it desirable that the genus *Belosepia* should be retained, it may be well to give a short description of the internal shell of the recent *Sepia officinalis*. This will be found to consist of five distinct parts: 1st, an outer layer of calcareous matter, called the *buckler* or sheath, convex, rugose externally, and prolonged at the posterior extremity into a calcareous spine, placed in the medial line, and inflected towards the ventral aspect; 2d, a series of horny layers imposed one over another, extending over the posterior dorsal surface of the buckler, and wholly enveloping and extending beyond the spine; 3d, a thin horny layer spread over the whole of the internal surface, and extending beyond the edges of the buckler, and which, in its turn, is entirely covered by, 4th, a calcareous layer, which contains the spongioid tissue and, 5th, a series of convex horny laminæ, impregnated with carbonate of lime, placed horizontally, the posterior edge of each succeeding lamina being a little withdrawn from that of the preceding lamina, so that by this mode of superposition they present a depression or cavity immediately above the origin of the spine, and gradually rise into a convex mass at the middle and upper extremity of the shell. The spaces between the laminæ act as air-chambers, but there is not any siphuncle or siphonal opening; and the surfaces of the laminæ are studded with an infinite number of minute columnar and sinuous partitions, placed at right angles to the laminæ, and giving them support.

It will be seen from this that the Belosepion, although bearing a close general resemblance to the Sepion, still presents several strongly-defined differences. The elevated calcareous mass or callus, which, in the Belosepion, terminates the sheath on the dorsal aspect, attaining frequently a considerable size, is not found in the Sepion; and the fold, which in the latter is represented by a series of horny layers, distinct from, but wholly enveloping, the spine, is, in the former, a thick calcareous plate, formed by the expansion and retroflection of the anterior extremity of the rostrum, and extending barely beyond the line of the callus. In the Sepion the rostrum is small, in some species little more than rudimentary, and inflected, if at all, towards the ventral aspect. In the Belosepion, on the contrary, it attains a very large size, and, as M. Pictet observes, would indicate a gigantic animal if it were in relation to the animal in the same proportion as the Sepion; and it is invariably inflected towards the dorsal aspect. The internal laminæ of the Sepion are horizontal, equidistant, and parallel, and so arranged as to form a hollow at the posterior ventral portion of the sheath, but rising into an elevated mass towards the middle; while in Belosepion, after emerging from the terminal cavity, in which they radiate, as it were, from the origin of the fold, they are at first nearly vertical, with the edges of the ventral margins ranged in a line with the ventral surface of the rostrum, and converging towards the inverted apex of the sheath; so that, as the sheath enlarges, the dorsal edges of the laminæ become more and more distant, and the laminæ themselves tend gradually towards a horizontal position; and in fact, in an adult individual, the last laminæ become nearly horizontal.

Owing to the different mode of arrangement of the laminæ, the *Sepion* and *Belosepion* differ materially in their shape and general aspect. In each the dorsal plate or sheath is extended so as to embrace the laminæ; but in the *Sepion*, the laminæ of which are horizontal, and placed in a direction nearly parallel with the sheath, it is necessarily much less convex and more extended than in the *Belosepion*, in which the laminæ, being vertical, or more or less vertically inclined, present to it merely their dorsal and lateral margins. The buckler of the *Sepion*, and its contents, are, therefore, in form an elongated oval, depressed in the direction from the ventral to the dorsal aspect, and but slightly convex on the surfaces; while in the *Belosepion* the sheath is considerably shorter, enlarging gradually towards the anterior extremity, and presents a deep semiconical cavity, containing within it the whole area of the laminæ, and it is obliquely truncated at the anterior extremity, and flat on the ventral surface, which does not extend to half the length of the shell. The most important difference, however, is, that the laminæ of the Belosepion possess large ventral, siphonal, or siphoniform openings, a structure which is not found nor represented in the Sepion.

These distinctions indicate corresponding zoological peculiarities; and the animal, although, perhaps, resembling Sepia more closely than any other recent Cephalopod, must yet have presented such marked differences from it as to render it impossible satisfactorily to refer its remains to that genus, and fully to justify the separation proposed by M. Voltz. I have, therefore, retained that author's genus, *Belosepia*, notwithstanding the array of authorities against it; and I have the less hesitation in doing this, when I find that Cuvier did not refer the remains in question to *Sepia*, but to some Cephalopod closely allied to that genus; and that M. de Blainville, when he adopted the genus *Beloptera*, did not hesitate to remove them from the genus Sepia, to which he had referred them, although he placed them, under some misapprehension, in the genus *Beloptera*.

With respect to the place of Belosepia in the systematic arrangement, as the shell presents a camerated and siphoniform structure and a terminal guard, and is therefore more nearly related to Belemnite than the recent Sepia, I have removed it from the family *Sepidæ*, in which M. d'Orbigny has placed it, to the family Belemnitidæ. It seems to have prepared the way for the recent Sepia, and leads from that genus, by a natural and easy transition through Beloptera and Belemnosis, into Belemnitella and Belemnite.

The specific characters are taken from the rostrum, the callus, and the fold. These parts, however, are of secondary importance only, and would vary in form considerably, not only with the age, but probably with the sex of the animal. Distinctions founded upon them, therefore, must necessarily be somewhat vague and uncertain; and, in fact, M. Deshayes, from not attaching sufficient importance to changes resulting from age or other circumstances, has proposed three distinct species, viz. *Belosepia longispina*, *B. longirostris*, and *B. Blainvillii*, on remains which, as well as those of the *B. Cuvieri* (of Deshayes), M. d'Orbigny considers to be varieties of the same species attributable to age.

Four well-defined species are known at present, viz. 1st, B. sepioidea (De Blainv.), consisting of S. longispina, S. longirostris, and S. Blainvillii (Desh.); 2d, B. compressa (De Blainv.); 3d, B. Cuvieri (Desh.), which I consider to be the B. Owenii of Sowerby; and 4th, B. brevispina (Sowerby). With the exception of the B. compressa, which has not yet been found in England, they all occur in the eocene strata of this country. The first three species are found in the Paris basin, and the B. Cuvieri has also been found in the tertiary deposits of Belgium.

No. 1. Belosepia sepioidea. *De Blainv.* Tab. I, fig. 1 *a—i*.

Beloptera sepioidea; *De Blainv.* 1825. Mal. add. et correct. p. 621, tab. 11, fig. 7.
Sepia Cuvieri; *D'Orb.* 1825. Tab. Méth. de la Classe Ceph. p. 67.
Beloptera sepioidea; *De Blainv.* 1827. Mém. sur les Bélem. p. 110, tab. 1, fig. 2, 2*a*, 2*b*.
— — *Sowerby.* 1829. Min. Con. vol. vi, p. 183, tab. 591, fig. 1.
Belosepia Cuvieri; *Voltz.* 1830. Obs. sur les Bélem. p. 22, tab. 2, fig. 6*a—g*.
Sepia Cuvieri; *Galeotti.* 1837. Mém. sur la Constit. Géogn. de la Prov. de Brabant, p. 140.
— longispina; *Desh.* 1837. Foss. des Env. de Paris, p. 757, tab. 101, fig. 4-6.
— longirostris; ,, ,, p. 758, tab. 101, fig. 10-12.
— Blainvilii; ,, ,, ,, ,, fig. 13-15.
— Cuvieri; *Bronn.* 1837. Lethæa Geognostica, p. 1127, tab. 42, fig. 19 *a—c*.
Beloptera longirostrum; *Morris.* 1843. Cat. of Brit. Foss. p. 178.
Sepia longirostris; *Pictet.* 1845. Traité élém. de Paléont. vol. ii, p. 315.
— longispina; ,, ,, ,, ,,
— Blainvillii; ,, ,, ,, ,,
— sepioidea; *D'Orb.* 1845-7. Moll. viv. et fos. vol. i, p. 269.
Belosepia Cuvieri; *J. D. C. Sowerby.* 1849. Dixon's Geol. Hist. of Bracklesham, Selsey, and Bognor, &c., p. 109, tab. 9, fig. 11*a*.
— longirostris; ,, ,, p. 109, tab. 9, fig. 15.
— longispina; ,, ,, p. 109, tab. 9, fig. 12.
— Blainvillii; ,, ,, p. 109, tab. 9, figs. 16, 17.
Non Sepia Cuvieri; *Desh.* Foss. des Env. de Paris, p. 758, tab. 101, figs. 7-9.

B. rostro elongato, crasso, acuto, recto aut plus minusve arcuato; laminâ ventrali crassâ, profundè radiatim sulcatâ, in margine posteriori denticulatâ; callo dorsali profundè et irregulariter rugoso, deorsum producto aut erecto.

This species presents considerable variations in the form, as well of the callus as of the rostrum; and, in fact, M. Deshayes has separated it into the three species *B. longispina*, *B. longirostris*, and *B. Blainvillii*, chiefly on account of the different conditions of the rostrum. M. d'Orbigny, attributing the variableness of the rostrum to the age of the animal, or to alterations caused by fossilization, to which I would also add changes resulting from attrition, has united these species under the specific name *B. sepioidea*, originally given by De Blainville. Possessing a long series of specimens, comprising individuals in different stages of growth, and in which the peculiarities of form, taken by M. Deshayes as specific characters, appear to pass gradually into each other, I have no doubt as to the propriety of the union, proposed by M. d'Orbigny, of the three species above mentioned. That author, however, has added to them a fourth species, proposed by M. Deshayes, *B. Cuvieri;* but which, as it exhibits constant and well-defined differences, I think should be retained.

The *rostrum* of *B. sepioidea* is elongated, and pointed at its posterior extremity; on the inferior or ventral surface it is sometimes, particularly when young, nearly straight, but more frequently it is bent, at about half the length, in an angle more or less obtuse, towards the dorsal aspect; the dorsal surface presents a sharp cutting edge, slightly arched, and, at its juncture with the callus, exhibits a depression, which is strongly marked in mature specimens. At the base, immediately beneath the callus, it is more or less dilated, and it is angulated at the margins; the ventral surface is more or less convex. The *callus* is narrow, compressed, and deeply rugose; the posterior margin forms an acute angle with the axis of the rostrum, varying considerably in different specimens. In some instances the inclination of the posterior margin is at an angle more or less obtuse with the axis of the rostrum; a condition which, as it appears to me, is attributable to the fracture and attrition of the extremity of the callus, as the specimens in which this form occurs present a smooth worn appearance. The *ventral plate*, immediately beneath the rostrum, is nearly horizontal, but presents a broad undulation, corresponding with the convexity of the ventral surface of the rostrum; the lateral extremities, as they approach the sheath, gradually diminish in breadth, and assume a nearly vertical position. In consequence of this variation in breadth, the ventral plate, which, at the superior margin, is nearly semicircular, presents a regular semielliptical form on the posterior margin. It exhibits on the ventral surface a series of sulci, radiating from the apex of the terminal cavity, and varying in depth; and it is deeply and sharply denticulated on the posterior margin. As the shell enlarges, the plate is thickened considerably by successive layers added to the ventral surface. The last layers frequently do not envelope, but are a little withdrawn from the margin of, the preceding layers, leaving the previous denticulations partly uncovered; and consequently the margin of the ventral plate, in an adult specimen, often presents a double row of denticulations.

The lateral portions of the sheath exhibit deep vascular impressions at the posterior extremity.

The *B. sepioidea* is found plentifully at Bracklesham Bay, on the coast of Sussex; it is also found at Stubbington (near Gosport) and at Sheppy. In France it occurs, according to M. d'Orbigny, in the lower calcaire grossier at Chaumont (en bas), Vivray, and Saint Germain; in the upper calcaire grossier at Chaumont (en haut), Grignon, Courtagnon, Parnes, Muchi-le-Châtel, &c., and, in the sandy beds above the calcaires grossiers, at Tancrou, Aumont, Acy, &c.

The specimen (Pl. 1, fig. 1*h*) exhibits nearly the entire form of the shell; it was found at Sheppy, and enriches the cabinet of Mr. Dixon. The length is four inches, and the breadth across the superior extremity of the sheath, if the cast were perfect, would be rather more than an inch. The remains commonly found seldom consist of more than the rostrum, with, occasionally, portions of the ventral plate, and, more rarely, of the posterior extremity of the sheath. The ordinary size of the rostrum is six tenths of an inch* long, and three tenths wide at the superior extremity.

No. 2. Belosepia Cuvieri. *Deshayes.* Tab. I, fig. 3 *a—e.*

Sepia Cuvieri; *Desh.* 1837. Foss. des Env. de Paris, p. 758, tab. 101, fig. 7-9.
— — *Nyst.* 1843. Descr. des Coq. et des Polyp. des Terr. tert. de la Belg. p. 610, tab. 46, fig. 1.
— — *Pictet.* 1845. Traité élém. de Paléont. vol. ii, p. 315.
— sepioidea (sp.); *D'Orb.* 1845-7. Moll. viv. et fos. vol. i, p. 269.
Belosepia Oweni; *J. D. C. Sowerby.* 1849. Dixon's Geol. Hist. &c. p. 109, tab. 9, fig. 13*a*.
Nec Sepia Cuvieri; *D'Orb.* 1825. Tab. Méth. de la Classe Ceph. p. 67.
Nec Belosepia Cuvieri; *Voltz.* 1830. Obs. sur les Bélemn. p. 22, tab. 2, fig. 6*a-g*.
Nec Sepia Cuvieri; *Sow.* Min. Con. vol. vi, p. 183, tab. 591, fig. 1.
Nec Belosepia Cuvieri; *J. D. C. Sow.* 1849. Dixon's Geol. Hist. &c. p. 109, tab. 9, fig. 11*a*.

B. Testâ extremitate posticali lateraliter dilatatâ; rostro brevi, crasso, arcuato, acuto, ad basim latissimo; laminâ ventrali arcuatâ, profundè sulcatâ, in margine denticulatâ; callo dorsali profundè rugoso, margine inferiori recto aut sursum vergenti.

M. Deshayes, in his description of this species, refers to Beloptera sepioidea (Beloptère de Cuvier) of De Blainville, and to the specimen figured by Mr. Sowerby in 'Mineral Conchology,' as identical with it. The description given by M. de Blainville is rather sub-generic than specific, and is too general for the purpose of identity; but the figures given by him are evidently those of a mutilated specimen of

* In stating the size of the shells I have used tenth parts of an inch, in order to facilitate a comparison with the measurements of French shells; as tenths of an inch may be readily, and with sufficient accuracy, converted into "millimetres" by taking 1 tenth as equal to $2\frac{1}{2}$ millim. The exact proportion is 305 millim. = 12 inches; i. e. ·1 in. = 2·54166 &c. millim.

B. sepioidea, and do not correspond with the specific description given by M. Deshayes. Through the kindness of Mr. Sowerby I have had an opportunity of examining the specimen from which his figure was taken, and it is unquestionably a B. sepioidea; the peculiar form of the rostrum being caused by the fracture of the posterior extremity, and the abrasion of the lower part of the outer layers. The present species is well defined by M. Deshayes; and as I have a series of specimens in different stages of growth in which the distinctions are preserved, I do not hesitate to retain it.

The *rostrum* is short, thick, slightly arched, and very broad at the superior extremity; on the dorsal surface, at the posterior extremity, it is compressed, and presents a cutting edge for about one half of the length; the superior extremity is marked by a broad depression extending to the callus. The *ventral plate* is less elliptical, and the denticulations less prominent, than in *B. sepioidea*. The *callus* is nearly perpendicular to the axis of the rostrum, and enlarges rapidly, owing to the greater width of the terminal cavity.

The specimen figured in Mr. Dixon's work, under the name *B. Owenii*, appears to belong to this species. Mr. Sowerby was probably induced, by the synonyms quoted by M. Deshayes, to consider the *Sepia Cuvieri* of that author as identical with the *Beloptère de Cuvier* of De Blainville; and as the specimen before him could not be referred to that species, he proposed the species *B. Owenii* for its reception. The specific name *Cuvieri*, however, having been improperly used by MM. d'Orbigny and Voltz for the *B. sepioidea* of De Blainville, must now be retained for the present species, to which it was applied by M. Deshayes, and it will consequently supersede the name *Owenii* proposed by Mr. Sowerby. M. Nyst cites for his specimens M. Deshayes's description of *B. Cuvieri*, and has, in fact, copied the figures given by that author. I have therefore considered them as identical.

Hitherto, I believe, B. Cuvieri has been found, in England, only at Bracklesham Bay, where it is not by any means common. The French localities quoted by M. Deshayes are Grignon, Courtagnon, Parnes (upper cal. gross.). M. Nyst gives the sandy beds at Boitsfort, Assche, Jette, Forêt, Ucele, and Ghent, as the Belgian localities.

The length of the rostrum is ·3 inch, and its breadth at the superior extremity ·3 inch.

No. 3. Belosepia brevispina. *Sowerby*. Tab. 1, fig. 2 *a—e*.

Belosepia brevispina; *J. D. C. Sowerby*. 1849. Dixon's Geol. Hist., &c., p. 109, tab. 9, fig. 14.

B. rostro per-brevi, crasso, acuto, in aspectum ventralem valde convexo et regulariter arcuato; laminâ ventrali profundè sulcatâ, vix denticulatâ; callo dorsali in margine inferiori compresso, sursum vergenti.

A species much resembling the young of *B. Cuvieri;* but, according to the few specimens we possess at present, it is distinguishable by the shortness and the greater convexity of the inferior surface of the rostrum, and also by the dorsal surface, which is rounder than in *B. Cuvieri*, slants downwards, and, even in the largest specimens, barely presents the cutting edge which distinguishes the two preceding species. The *callus* is longer in proportion, and is so much compressed, as to present a narrow, almost a sharp edge; and it enlarges more rapidly than even in the last species, owing to the greater width of the terminal cavity.

The *ventral plate* is semicircular, and nearly smooth on the inferior margin, and, owing to the width of the cavity, is transversely elliptical on the superior margin; it is also narrower and more deeply sulcated than in *B. Cuvieri.*

The *B. brevispina* is found at Bracklesham Bay, and is very rare. I possess four specimens of different sizes, which all present the same characteristic form; but it is not improbable that a larger series would show that the species is but the young form, or at all events only a variety, of *B. Cuvieri.*

The length of the rostrum is ·2 inch; the width rather less than ·2 inch.

Genus 2d. BELOPTERA. *Deshayes.**

Animal unknown, but supposed to have been closely allied to the Belemnite, which, as described by Professor Owen, appears to have been oblong; the head, surrounded by ten arms, (?)† furnished, like those of the recent genus *Onychoteuthis*, with a double alternate series of slender, clongated, horny hooks; mandibles horny; (?) the body purse-shaped, conical, elongated, supporting near the middle two lateral fins, rounded and entire along their free margin; inclosing an ink-bag.

Shell internal, composed of two cones placed apex to apex, united, and expanding on each side into wing-shaped appendages, obliquely inclined towards the ventral aspect; the anterior cone smooth, longitudinally fibrous, hollowed into a deep conical cavity, containing regular transverse concave septa, pierced by a ventral siphon.

B. Testâ internâ, duobus conis, apice ad apicem conjunctis, formatâ; utroque latere duobus appendicibus aliformis, deorsum inclinatis, sustentâ; superficie dorsali convexâ, ventrali concavâ; cono anteriori lævigato, longitudinaliter fibroso, cavitati conicâ, profunda, septa transversa continenti, excavato; septis concavis, regularibus, siphone ventrali perforatis.

Guettard, the first author by whom these remains appear to have been noticed,

* Etym. Βελος, telum; πτερον, ala.

† The eight *sessile* or normal arms only have as yet been found preserved. Professor Owen states that the traces of the superadded pair of tentacula are somewhat doubtful.

described them as the teeth of fish. Long subsequently, M. Deshayes examined similar remains found in the Paris basin; and, having observed in them characters which induced him to refer them to an extinct Cephalopod nearly allied to the Belemnites, he proposed the present genus for their reception. M. de Blainville, whose 'Manuel de la Malacologie' was then in course of publication, and to whom M. Deshayes had communicated his proposed genus, confounded with the remains in question those of the so-called fossil Sepiæ (Belosepiæ); but in adopting the genus *Beloptera*, he divided it into two sections, the first containing the fossil Sepiæ, which he characterised as species having wing-shaped appendages united at the superior extremity of the rostrum; the second section containing the true Belopteræ, he described as species having the appendages distinct and the cavity conical, and with chambers and a siphuncle. The mistake is continued by M. de Blainville, in the Supplement to his 'Mémoire sur les Bélemnites,' published in 1827. In 1830, Voltz pointed out the differences which rendered it necessary to keep the two genera distinct; and, about the same time, M. Deshayes published, in the 'Encyclopédie Méthodique,' under the article Béloptère, the grounds which induced him to establish that genus. Notwithstanding this publication, however, the error into which M. de Blainville had fallen was repeated by MM. d'Orbigny and de Férussac, in their 'Histoire des Céphalopodes,' and by Cuvier, in his Memoir on the bones of the fossil Cuttle-fish, published in the 'Annales des Sciences Naturelles.'

Mr. Sowerby afterwards, when he adopted the genus provisionally for the curious and unique fossil obtained from Highgate, which he published in the 'Mineral Conchology' under the name *Beloptera anomala*, confined the genus to those species which contained a chambered cone like the Belemnites, and referred the species contained in M. de Blainville's first section to the genus *Sepia*. The absence, in the Highgate fossil, of the lateral wing-shaped expansions, and of the blunt terminal rostrum which characterise the two known species of *Beloptera*, as well as other characters to which I shall hereafter refer, seems to me to require the establishment of a distinct genus for the reception of those remains; and the genus *Beloptera* will be then confined to those species which possess lateral expansions, and which, as M. Deshayes himself describes them, exhibit an entire conical and chambered cavity, resembling that of the Belemnite, joined to a terminal rostrum, like that of the Belosepia.

As thus restricted, the *Belopteræ* present, at the anterior extremity, a semiconical cavity, slightly depressed on the ventral aspect, in which was contained a thin calcareous layer, covering the entire inner surface. The inner cone formed by this layer contained a series of transverse, regular, and exceedingly thin septa, traces of which, consisting of their sutures or lines of junction with the inner sheath, are very distinct. These sutures, as they approach the ventral aspect, are slightly bent downwards towards the inverted apex of the cone, and present an acute sinus-like inflection as they rise over a slight linear elevation, which traverses the whole length of the alveolus, along the medial line of the ventral inner surface, evidencing the presence and position of the siphuncle. The opening, or anterior extremity of the conical cavity, is slightly elliptical, having the shorter axis in the direction from the ventral to the dorsal aspect. The margin of the outer sheath is thin and sharp, and its ventral paries is much thicker than the dorsal paries, and rises into an elevated mass, depressed on the surface. The outer sheath itself is composed of a series of concentric layers, and exhibits a fibrous texture, like the sheath of the Belemnite. The apex is prolonged into a dense calcareous mass, strongly inflected towards the ventral aspect, and enlarged towards the posterior extremity, where it becomes attenuated, and is obliquely truncated. This mass is composed of longitudinal laminæ, radiating from the apex of the cone, and so arranged, that the central laminæ are in a plane extending from the ventral surface to the back, and the rest in planes gradually diverging more and more towards the back. The outer edges of the laminæ are distinct and slightly elevated, giving a rough sulcated appearance to the surface. The cone and the calcareous mass into which it is prolonged expand laterally into two smooth semi-elliptical appendages, inclined obliquely towards the ventral aspect, thin and sharp on the outer edges, and gradually thickening as they approach their bases. These expansions consist of two distinct series of layers, deposited on the ventral and dorsal surfaces, and exhibit impressions which, as M. Deshayes remarks, are probably attributable to the presence of a vascular system in the substance of the mantle.

It will be seen from the foregoing description that *Beloptera* presents a much closer analogy with the Belemnites than that exhibited by *Belosepia*. The open semiconical cavity of the latter, in its typical form, nearly resembles the sheath of the Sepion; but the laminæ, both in their mode of arrangement and in their large siphoniform openings, present the first indications towards the phragmocone of the Belemnite. In the aberrant form, *Belosepia compressa*, both the sheath and the laminæ recede a step further from the Sepion type, and prepare the way for, and in fact connect *Belosepia* with, *Beloptera*. In this genus a still nearer approach to Belemnite appears; the wide, open, but shallow sheath of the Sepion, with its siphonless and nearly parallel laminæ, is lost, and is replaced by an entire conical sheath, containing regular transverse septa perforated by a siphuncle, and exactly corresponding with the sheath and phragmocone of the Belemnite. The fold of the Belosepion, formed by the retroflexion and lateral enlargement of the ventral paries of the sheath, largely developed in the typical form, disappears in *Beloptera*, and is represented by the lateral expansions which characterise that genus, and which, greatly reduced in size in *Beloptera Levesquei*, lead directly into the simple sheath of the Belemnite; while the strongly inflected rostrum of the Belosepion assumes the form of a somewhat conical mass, and thus prepares the way for the elongated and regularly conical guard of Belemnite.

Exclusive of the Beloptera anomala (Sow.), for which I have proposed the genus *Belemnosis*, only two species of Beloptera are as yet known, i. e. *B. Belemnitoidea*, and *B. Levesquei.* Both species occur in the Paris basin, and in the Eocene beds of England. The first has also been found at Laeken in Belgium, and at Biaritz.

The specific characters are taken from the conditions of the lateral expansions and of the conical sheath.

No. 4. Beloptera Belemnitoidea. *De Blainville.* Tab. 2, fig. 1*a*—*g*.

Tooth of a fish ; (?) *Guettard.* 1783. Mém. sur les Glossopètres, tab. 2, figs. 10, 11, 12.
Beloptera Belemnitoidea ; *De Blainv.* 1825. Mal. add. et correct. p. 621, tab. 11, fig. 8.
Sepia Parisiensis ; *Fér. et D'Orb.* 1825. Tab. Méthod. des Céph., Ann. des Sc. Nat. vol. vii.
Beloptera Belemnitoidea ; *De Blainv.* 1827. Mém. sur les Bélemn. p. 111, tab. 1, figs. 3, 3*a*, 3*b*.
— — *J. D. C. Sowerby.* 1829. Min. Con. vol. vi, p. 183, tab. 591, fig. 3.
Beloptera Belemnoidea ; *Voltz.* 1830. Obs. sur les Bélemn. p. 20.
Beloptera Belemnitoidea ; *Deshayes.* 1830. Encyc. Méthod. vol. ii, p. 135.
— — *Keferstein.* 1834. Die Naturgeschichte der Erdkörpers, &c. p. 430, No. 2.
— — *Deshayes.* 1837, Descrip. des Foss. des Env. de Paris, p. 761, tab. 100, figs. 4-6.
— — *Bronn.* 1837. Lethæa Geog. p. 1129, tab. 42, fig. 18*a-b*.
— — *Fér. et D'Orb.* 1839. Céph. Acetab. Seiches, tab. 3, figs. 7-9 ; tab. 24, figs. 11-12.
— — *Nyst.* 1843. Descr. des Coq. et des Polyp. foss. &c. p. 612, tab. 6, fig. 2.
— — *Pictet.* 1845. Traité élément. de Paléont. vol. ii, p. 316 ; tab. 14, fig. 2.
— — *Deshayes.* 1845-6. 2d Edit. de l'Histoire Nat. &c. p. 243.
— — *D'Orb.* 1845-7. Moll. viv. et foss. vol. i, p. 308, tab. 14, figs. 1-4.
— — *J. D. C. Sowerby.* 1849. Dixon's Geol. Hist. of Bracklesham, &c. p. 109, tab. 9, fig. 18.

B. testâ ovato-elongatâ, longitudinaliter recurvâ; supra convexâ; subtus concavâ, depressâ; cavitate anticâ sub-cylindricâ: rostro obtuso, striato: appendicibus lateralibus magnis, semicircularibus.

Shell oblong, compressed; the sheath straight and nearly elliptical; the ventral paries considerably thickened and depressed on the medial line below the siphuncle, so as to present an elevated sub-quadrate ridge, bifurcated at the posterior extremity. The rostrum enlarges gradually for about two thirds of the length, and then diminishes towards the extremity, which, in young specimens, is nearly conical in form, but in adult ones becomes very obtuse, probably from attrition; it is inflected towards the ventral aspect whence the shell presents longitudinally a somewhat arched appearance. The lateral expansions are inclined towards the ventral aspect, and give a convex form to the dorsal surface, and a corresponding concavity to the ventral surface; they are thick at the juncture of the rostrum and sheath, and become gradually thinner as they enlarge, presenting a sharp cutting edge on their free outward margins. In this, the typical species, they are largely developed, regular in form, and vary considerably in size according to the age of the individual; in young specimens they present an elongated semielliptical form, which, as the shell advances towards maturity, becomes nearly semicircular.

Figs. 1*f* and 1*g* represent a variety in which the inferior cone is shorter, broader, and more compressed, and the wings are wider than in the ordinary specimens.

The *B. Belemnitoidea* is found in England at Bracklesham Bay, where it is somewhat rare. In France it is found in the nummulitic bed at Biaritz, in the Lower Pyrenees; the lower beds of the calcaire grossier at Vivrais, Grypseuil, and Pouchon (Oise), and, in the middle beds, at Grignon, Parnes, Muchi-le-Châtel, Chaumont, &c. It also occurs in Belgium, in the sandy beds at Laeken.

The size is eleven lines in length, and four lines and a half in width across the widest part of the lateral expansions.

No. 5. Beloptera Levesquei. *D'Orbigny.* Tab. 2, fig. 2*a*—*e*.

Beloptera Levesquei; *D'Orb. et Fér.* 1839. Céphal. Acetab. Seiches, tab. 20, figs. 10-12.
— — *Pictet.* 1845. Traité élément. de Paléont. vol. ii, p. 316.

B. testá oblongo-elongatá, arcuatá, subtus carinatá, lateribus depressá, sub-excavatá; anticè cylindrico-angustatá: rostro obtuso, striato: appendicibus lateralibus parvis, linearibus.

Shell elongated, arched: the sheath straight and nearly cylindrical; the ventral paries thickened, and laterally much compressed, so that, instead of the flat square-shaped, bifurcating ridge which distinguishes the preceding species, it presents along the middle of the sheath, beneath the siphuncular line, a somewhat acute angular keel, which is continued on the upper part of the rostrum, and the sides of which are a little depressed. The rostrum itself is larger, and is transversely more compressed, and less inflected towards the ventral aspect, than that of *B. Belemnitoidea.*

M. d'Orbigny describes the species as destitute of lateral expansions; but, in the figures given by him, there are unquestionable indications of those appendages, very slightly developed it is true, yet still representing the wing-shaped expansions which characterise the genus. In one of the two English specimens, the only two with which I am acquainted, and for the use of which I am indebted to Mr. Wetherell, the lateral expansions are broken away, but their existence is evidenced by a deep suture on each side where they were inserted into the shell. The other specimen unfortunately is broken off just above the juncture of the sheath with the rostrum, at the precise part at which the expansions would first appear; but their presence is indicated by a slight curve in the outline caused by their origin. I do not hesitate, therefore, to attribute to this species the characteristic lateral enlargements, although they are very feebly developed.

M. Deshayes, in his 'Description des Coquilles fossiles des Environs de Paris,' mentions a specimen in his possession, too much mutilated for description, in which the rostrum is smoother and more elongated, and the wings appear to be much narrower than in B. Belemnitoidea, and not to be inclined downwards as in that species; and for which, when better known, he thinks it will be necessary to form a new species. May not that specimen be referred to this species, which has been established since the publication of M. Deshayes's work?

The English specimens of this species have hitherto been found only at Highgate, and are exceedingly rare. In France, according to M. d'Orbigny, the species occurs only in the lower strata of the Paris basin; that is to say, in the sands below the nummulite bed, at Thury-sous-Clermont, Gilocourt, and Cuise-Lamotte (Oise).

The size is twelve lines long and three lines wide.

Genus 3d. BELEMNOSIS.* *F. E. Edwards.*

BELOPTERA; *J. D. C. Sowerby.*

Animal unknown but supposed to be closely allied to the Belemnite.

Shell internal, oblong, semiconical, with the apex inflected towards the ventral aspect, and enlarged into an obtuse umbo, pierced by a pore on the ventral surface; the anterior part hollowed into a deep semiconical cavity extending to the pore, and having the inner surface covered by two calcareous sheaths, one within the other, continued over the ventral surfaces of, and enveloping, a series of transverse septa, perforated by a ventral siphon.

Testâ internâ, oblongâ, semiconicâ, apice deorsum inflecto et in umbonem obtusum, foramine perforatum, dilatato; parte anteriori in cavitatem semiconicam, profundam, ad foramen tendentem, et septa transversa, siphone ventrali perforata, continentem, excavatâ; cavitatis superficie duobus laminis conicis, pertenuibus, circa septa productis et ea involventibus, obtectâ.

The remarkable remains for the reception of which I propose the present genus are described by Mr. J. Sowerby in the 'Mineral Conchology,' and are referred by that author to *Beloptera.* M. Deshayes, in the first instance, in the 'Description des Coquilles fossiles, &c.,' expressed an opinion that they could not be placed in that genus; subsequently, however, in the notice of the genus Beloptera, introduced in the second edition of Lamarck, after speaking of *Belop. Levesquei,* he refers not only that

* Etym. Βελεμνον, telum; ενωσις, conjunctio.

species but also the *Beloptera anomala* of Sowerby to the genus Beloptera, the principal character of which he states to be the association of a conical chambered cavity, similar to that of the Belemnites, with the beak (rostrum) of the Sepia. M. d'Orbigny also (Moll. viv. et foss.) refers to that genus the remains in question, which, he says, resemble *Beloptera Levesquei* in the absence of the lateral wings, but are distinguished from it as well by the want of the under part (the ventral paries) of the shell and of a distinct beak, as by the air-chambers being apparent on the under side. These remains unquestionably bear a close affinity to Beloptera; but the peculiarities they present appear to me to separate them distinctly from that genus, and fully to justify the establishment of a new genus for their reception.

The shell of *Belemnosis* consists of an elongated semiconical sheath, the apex of which expands into a short semicylindrical umbo, pierced on the ventral surface, and inflected towards the ventral aspect. The sheath is convex on the dorsal surface, and is without a ventral paries; the margins at the superior extremity are narrow, and present outwardly sharp edges, which extend rather more than one third of the length of the shell; as the margins approach the inferior extremity they expand, and the inner edges gradually become nearer to each other, until they unite immediately above the umbonal pore. The margins of the pore are elevated, and the pore itself penetrates to, and communicates with, the air-chambers. The septa are transverse and concave; the presence of a siphuncle and its ventral position are indicated by angular inflections on the sutural impressions along the medial line of the ventral surface; the septa are contained in, and wholly enveloped by, a thin conical sheath, which also is covered by a second and somewhat thicker conical layer lodged in the outer sheath.

The principal character of *Beloptera*, viz., the association of the elongated rostrum of the Sepion with the phragmocone of the Belemnite, fails in *Belemnosis;* and the lateral expansions which, assuming their fullest development in *Beloptera Belemnitoidea*, still characterise *B. Levesquei*, although reduced in that species to prominent carinæ, are here wanting, or, at the utmost, are but feebly represented by the sharp outer edges of the ventral margins of the sheath. In *Beloptera*, the outer cone, which contains the inner sheath and its contents, and which exactly corresponds with the phragmocone of the Belemnite, is entire; whereas, in *Belemnosis*, the ventral paries is wanting, or very thin. In this respect *Belemnosis* presents an analogy with *Belemnitella* (D'Orb.), a genus of the Belemnitidæ, characterised by a fissure in the phragmocone communicating with the external paries of the alveolus. This peculiar form of Belemnite at present appears to be confined to the upper chalk formation, and it would seem to connect the true Belemnite with the present genus, in which the fissure becomes largely expanded, resembling the wide cavity of Belosepia. Thus the transition from *Belosepia*, through *Belemnosis* and *Belemnitella*, into *Belemnite* will be easy and natural, and the chain of connexion between the latter genus and the recent *Sepia* will be complete.

The principal character, however, which distinguishes *Belemnosis* is the aperture forming a communication between the alveolar chambers and the sac in which the shell was lodged. In all the camerated siphoniferous shells, I believe without exception, the inferior extremity of the alveolus and phragmocone is perfectly closed, and the air-chambers have not any direct communication with the pallial sac; and, in fact, communicate only with the pericardial cavity by means of the membranous siphuncle. Walch, it is true, in his 'Recueil de Monumens, &c.,' figured a Belemnite, which he described as having a small circular hole at the extremity of a curved point; upon which figure, with embellishments of his own, De Montfort proposed the genus *Paclites,* referred to by Parkinson, and quoted by De Blainville. This genus, however, is universally rejected, as founded on characters merely accidental or imaginary. M. d'Orbigny states, that in certain exceptional cases the extremities of the rostra of Belemnites, at the last period of their growth, form tubular prolongations, and that they are also liable to distortion from accident. The extreme points of the successive layers, which form the spathose guard, are apparently, in some instances, more susceptible of disintegration than the other parts, and thus tubular openings may be formed along what Voltz terms the *apicial line.* But in all these cases the pore is merely terminal, and does not extend far up the sheath. The structure found in *Belemnosis*, therefore, appears to be peculiar to it; and would indicate an application of the siphuncular function, whatever that function may be, different from that in all other siphoniferous shells, and suggests a corresponding peculiarity in the organization of the animal.

From the absence of the elongated rostrum which characterises the *Belosepia* and *Belopteræ,* we infer that the animal of *Belemnosis* was not littoral in its habits, but existed in a comparatively deep sea; and the occurrence of the unique specimen, upon which the genus is founded, at Highgate, where the organic remains indicate a shallow-sea deposit, is attributable most probably to the casual drifting of the animal.

No. 6. Belemnosis plicata. *F. E. Edwards.* Tab. 2, fig. 3*a*—*e*.

Beloptera anomala; *Sowerby.* 1829. Min. Con. vol. vi, p. 183, tab. 591, fig. 2.
— — *Morris.* 1843. Cat. of Brit. Foss. p. 178.
— — *Pictet.* 1845. Traité élément. de Paléont. tom. ii, p. 316.
— — *Deshayes.* 1845-6. 2d Edit. de l'Hist. Naturelle, &c. par Lam.
— — *D'Orbigny.* 1845-7. Moll. viv. et foss. tom. i, p. 309, tab. 14, figs. 8-10.

B. testâ oblongo-elongatâ, supra convexâ, umbone obtusissimo, lateraliter compresso, et deorsum leviter inflecto terminatâ: marginibus ventralibus anticè depressis, posticè sub-convexis, facies externas acutas, internas, obliquè triplicatas, præbentibus: foramine umbonali circulari.

This shell is oblong, regularly convex on the upper surface, and terminated by a very obtuse, short umbo, compressed laterally, and slightly inflected towards the ventral aspect. The ventral margins are depressed, and present outwardly sharp edges, which extend rather more than one third of the length of the shell; the margins assume a convex form as they approach the inferior extremity, and at about two thirds of the length, become and continue nearly parallel until their union above the umbonal pore. The inner edges present three obscure, very oblique folds, from which character the specific name is taken. The umbonal pore is circular, and extends to the pyrites, with which the phragmocone is filled; it is about one fourth of the breadth of the shell in diameter. The septa are distant.

This unique and valuable specimen enriches the cabinet of Mr. Sowerby, whose kindness in conceding the use of it for description I beg to acknowledge. It was found in the clay removed in constructing the archway at Highway.

The length is ·5 in.; the breadth at the upper extremity is ·25 in., and across the umbonal pore ·15 in.

Order—*TETRABRANCHIATA.* *Owen.*

Family—Nautilidæ.

According to Von Buch, the division, which has been made of the tetrabranchiate Cephalopods into the two great families *Nautilidæ* and *Ammonitidæ*, has been determined solely by the position of the siphuncle, which, in the latter family, is invariably placed on the *ventral* margins of the septa; while, among the *Nautilidæ*, it is placed at or near the *centre* of the discs of the septa. Other differences exist in the form and condition of the septa, which, among the *Nautilidæ*, are characterised by simple curvatures or undulations, and by having their margins entire; while, among the *Ammonitidæ*, the septa present a series of lobes or sinuous flexures, the margins of which are foliated.

A third group, however, exists, in which the siphuncle is placed on the *dorsal* margin, and the septa are distinguished by angular or rounded lateral lobes, but their margins are perfectly simple. This group, for the typical forms of which Count Münster established the genus *Clymenia*, has been hitherto generally associated with the Nautilidæ; but I propose to separate it as a distinct family, under the name *Clymenidæ*.

The *Nautilidæ* will then be confined to those genera in which the siphuncle is *central* or *excentric*, that is, placed at the centre of the disc of the septum, or between that and the margin; or, more strictly, to those in which it is not placed either on the ventral or on the dorsal margin.

As thus restricted, the Nautilidæ will consist of the following genera: *Nautilus*, *Planulites,* Lam., *Gyroceras, Lituitus, Campulites,* Desh. (Cyrtoceras, Gold.), *Phragmoceras, Orthoceras, Actinoceras, Koleoceras,* Portl., and *Poterioceras,* M'Coy (Gomphoceras, Sow.)

Of these genera, the Nautilus only has been found above the secondary formations.

The generic distinctions are taken chiefly from the position of the siphuncle, and the mode of convolution or the form of the shell.

Genus 4. NAUTILUS—*Gualtieri, Linnæus.*

OCEANUS; BISIPHITES. *De Mont.*

OMPHALIA. *De Haan.*

Gen. desc. Animal; *body* oblong, posteriorly rounded, and terminating in a slender membranaceous tube; *head* above, with an ambulatory disc; *arms,* nineteen (?) on each side;* *labial tentaculiferous appendages,* four, arranged round the mouth; *tentacula* of three kinds, viz. *ophthalmic,* lamellose, two on each side; *brachial,* annulose, twenty on each side; *labial,* annulose, twenty-four on each side; the whole body contained in the last chamber of a large multilocular shell, and affixed by two lateral muscles.

Shell; discoidal, spiral, multilocular, with simple walls; the whorls contiguous, the last covering the others; septa transverse, concave without, perforated in the disc, margins quite simple.

Animal corpore *oblongo, postice rotundato, tubo gracili membranaceo terminato;* capite *supra disco ambulatorio;* brachiis *utrinque novemdecem;* (?) appendicibus labialibus tentaculiferis, *quatuor, circum os dispositis;* tentaculis *trium generum, quorum,* ophthalmicis, *lamellosis, utrinque duobus;* brachialibus, *annulosis, utrinque viginti;* labialibus, *annulosis utrinque viginti quatuor; toto corpore in camerâ ultimâ testæ magnæ multilocularis recondito et musculis duobus lateralibus affixo.*

Testâ discoideâ, spirali, polythalamiâ, parietibus simplicibus; anfractibus contiguis, ultimo alios obtegente; septis transversis, extûs concavis, disco perforatis, marginibus simplicibus.

The Nautilus is the only genus of the Cephalopoda which, appearing among the earliest forms of animal life, has survived the various changes which the earth has undergone. The large family, of which it forms the type, flourished during the Palæozoic epoch, and the Nautilus itself apparently attained its fullest development during the deposition of the carboniferous series, at which period nearly fifty species existed. Gradually diminishing in numbers, the genus passed through the Mesozoic epoch into the tertiary era, which it has also survived; and though reduced to four species, which have not any fossil representative,† it still exists in the tropical seas.

* M. Valenciennes states the number to be seventeen.

† The identification of the species in the Miocene formations of Turin cannot be relied upon.

The Nautilus appears to have been known to Aristotle, of whose shell-bearing polypi, the second is considered to be the Nautilus Pompilius ; the first species, the true Nautilus of the ancients, and to which Gualtieri gave the name *Cymbium*, is the *Argonauta* of Linnæus. Although the shell of the recent Nautilus has long been commonly known, little information existed as to the animal, beyond that given by Aristotle, until a comparatively recent period. At the beginning of the last century the Dutch naturalist Rumph drew the attention of zoologists to the animal of the Nautilus; a description of which, illustrated by figures, he gave in his work 'D Amboinische Rariteitkamer.' From Rumph's description, which, however imperfect, was more intelligible than his drawing, De Montfort gave an imaginary representation of the animal, wide of the truth, but which was adopted by Shaw. After the time of Rumphius not any additional information was procured until the arrival in England, in 1831, of a specimen of the *Nautilus Pompilius*, taken by Mr. Bennett in Marachini Bay on the south-west side of the island of Erramonga, one of the New Hebrides. It is true that in the preceding year MM. Quoy and Gaimard had published, in the 'Annales des Sciences Naturelles,' an account of a portion of some unknown molluscous animal, which they supposed to be the *Nautilus Pompilius*, found near the island of Celebes ; but the remains were too imperfect for satisfactory description, and, in fact, they have generally been attributed to a Heteropodous Mollusc, either Carinaria or Pterotrachea. The specimen brought over by Mr. Bennett was placed in the hands of Professor Owen, who in 1832 published his Memoir before referred to with minute anatomical descriptions and illustrations. In 1839 M. Valenciennes published an account entitled 'Nouvelles Recherches sur le Nautile flambé,' taken from an individual transmitted to the Museum of Natural History at Paris. These two works afford ample information as to the animal, but it is unnecessary to enter into the details, a brief outline, sufficient for the present purpose, having already been given. Of the soft parts of the animals which inhabited the fossil shells, no trace has been found to assist the Palæontologist, who must, therefore rely wholly on the calcareous remains for specific distinctions. As regards the tertiary species, these distinetions appear to be tolerably well defined ; and but little difficulty will be found in the determination of the species.

The shell is smooth, spiral, and symmetrical; suborbicular, or somewhat depressed, and more or less round on the ventral aspect; the margins of the aperture are smooth and simple ; the whorls are contiguous, and convoluted in a vertical plane, the last being the largest and concealing the rest, by which character it is distinguished from *Planulites*, the whorls of which are exposed. In some species the umbilicus is open ; but more generally it is closed, as in the adult specimens of the recent *N. Pompilius*, by a deposition of nacreous or calcareous matter. The lines of growth are distinct, and in some species strongly marked, giving a somewhat striated appearance to the shell ; and they are reflected backwards, in which respect they differ from those of the *Ammonitidæ*, which are bent forwards. The chambers are separated by transverse partitions, more or less undulated; and in one species, *N. Parkinsoni,* they are distinguished by lateral angular lobes, resembling those of *Aturia* (*Nautilus*) *zic-zac,* and the margins are invariably simple and entire. The discs of the septa are perforated at the centre, or at parts more or less distant from the margins, but never at the margin, by a calcareous siphuncle, variable in size and generally discontinuous, that is, extending more or less into the preceding chamber, but not into the preceding siphuncular aperture. The chambers themselves increase in size to the last, which is sufficiently large to contain the whole of the animal; but the ratio of increase is apparently uncertain, and is influenced probably by the growth of the animal, which would, of course, depend on the supply of food and other circumstances.

The fossil substances termed *Rhyncolites,* which occur so frequently in the older formations, and which are generally believed to be the mandibles of some of the Tetrabranchiate Cephalopods, with whose remains they are associated, have been found both in the Paris basin and in the tertiary formations in Belgium; but I believe that as yet they have not been found in the Eocene strata of England.

The specific characters in this genus are taken from the curvature of the septa, the general outward form of the shell, (which, in fact, determines the shape of the septum,) the position of the siphuncle and the condition of the umbilicus. With respect to the terms *dorsal* and *ventral,* it must be borne in mind that they are used in the following descriptions in a sense directly the reverse of that in which they have been generally applied. The Nautilus, in its normal position, rests upon, or creeps along the ground by means of, the free and expanded anterior portion of the mantle. In this position the back of the animal is against the penultimate whorl of the shell, and the ventral part is contained within the concavity of the dwelling-chamber. In the following descriptions, therefore, the term *dorsal* is used to designate the parts contiguous to the penultimate volution of the shell, and which have been generally, though incorrectly, described as ventral; and the term *ventral,* on the other hand, will be applied to those parts on which the belly of the animal rested, and which hitherto have usually been termed dorsal.

At present six species have been found in the tertiary strata of England, and they are confined to the older Eocene deposits. In the contemporaneous strata of the Paris basin two species occur, one of which is also found in Belgium; but not either of them has as yet been found in England; and four species have been described by Sismonda and Michelotti, as occurring in the Miocene formations in Piedmont. Two of these last species are referred by those authors to existing species; but the accuracy of the identification is questioned.

No. 7. Nautilus centralis. *Sowerby.* Tab. III, fig. 1*a*—*c*.

Nautilus centralis. *J. Sow.* 1812. Min. Con. vol. i, p. 11, tab. 1, left-hand figure.
— australis (by error for centralis). *Defrance.* 1825. Dict. des Sc. Nat. vol. xxxiv, p. 297.
— centralis. *Wetherell.* 1836. Philos. Mag. and Journal, vol. ix, p. 465.
— Bucklandi. (?) *Michelotti.* 1840. Ind. rag. di alcuni Testacei de Cefal. foss. &c. Ann. delle Scien. del Regno Lomb.-Veneto, p. 4.
— centralis. *Morris.* 1843. Cat. Brit. Foss. p. 182.
— — *Pictet.* 1845. Traité élément. de Paléont. vol. ii, p. 338.
— — *Sow.* 1849. Dixon's Geol. Hist. &c. pp. 110, 121, tab. 14, fig. 28.

N. testâ globosâ, in aspectu ventrali rotundatâ; aperturâ semilunari; umbilicatâ, umbilicis angustis, profundis; septis extûs concavis, simplicissimis, siphone centrali, minimo, continuo perforatis; lobis dorsalibus latis, haud reflexis.

The N. centralis, in the simplicity of the septa and the central position of the siphuncle, nearly resembles the recent Nautili. It is a very ventricose, almost a globose shell, much rounded on the ventral aspect; the aperture is bluntly lunate, nearly semicircular, and is rather more than twice as wide as it is long; the open umbilicus is narrow and deep; the septa are concave outwardly, and simple, scarcely presenting any undulation or second curvature whatever; the dorsal lobes are broad, each being nearly one third of the width of the aperture, and they are bluntly rounded on their superior margins; the siphuncle is very small, central, or nearly so, and continuous. The lines of growth present broad undulations, and are strongly marked and decussated.

Michelotti has described a Nautilus from the Miocene formations of the Colle de Torino, in Piedmont, to which he has given the name *Bucklandi.* He quotes *N. centralis* of Sowerby by the name *N. australis* (an error into which he has fallen by relying on Defrance's quotation), and he considers his shell to be identical with it, and, oddly enough, associates with it *N. imperialis.* The specific description given by this author agrees tolerably well with that of the present species; but I have not myself had any opportunity of comparing the Piedmontese with the English shell; and as Michelotti does not mention his having compared the two, and he appears to have trusted implicitly to Defrance, the accuracy of the identification must for the present be considered as doubtful.

Mr. Wetherell, in his paper above quoted, gives this species and *Naut. regalis* as characteristic of the middle division of the three which he thinks might be made of the true London Clay. It occurs at Regent's Park, Chalk Farm, Hyde Park, Richmond, Sheppy, and Bognor; it is also found, though very rarely, at Bracklesham Bay.

The species does not appear to have attained a great size, the largest specimen not exceeding 3·7 in. in diameter, by 3·3 in. across. The figs. 1 and 2, Tab. III, are taken from specimens in the collection of Mr. Wetherell; fig. 3, from one in that of Mr. Sowerby. The form of the septum is shown by fig. 2, Tab. VIII.

No. 8. Nautilus regalis. *Sowerby.* Tab. IV.

Nautilus regalis. *J. Sow.* 1823. Min. Con. vol. iv, p. 77, pl. 355.
— — *Def.* 1825. Dict. des Sc. Nat. vol. xxxiv, p. 300.
— — *Weth.* 1836. Philos. Mag. and Journ. vol. ix, p. 465.
— — *Morris.* 1843. Cat. Brit. Foss. p. 183.
— — *Pictet.* 1845. Traité élément. de Paléont. vol. ii, p. 338.
— — *Sow.* 1849. Dixon's Geol. Hist. &c. p. 120.

N. Testâ lævigatâ, sub-ventricosâ, in aspectu ventrali compressâ, obscurè undulatâ; aperturâ obtusè-ellipticâ; umbilicis obtectis; septis simplicibus, concavis, utroque latere perparum undulatis, siphone sub-centrali perforatis; lobis dorsalibus brevibus, rotundatis, haud reflexis.

The present species is distinguishable from the preceding by the closed umbilicus, and by its general form, which is less ventricose than that of *N. centralis.* It is a smooth shell, flattened on the sides, and bluntly rounded, and obscurely undulated on the ventral aspect. The aperture presents a subquadrate appearance. The umbilicus is closed by a thickening of the lip, assuming the appearance of a solid axis to the shell. The septa are nearly simple, presenting on each side slight undulations, and the short, rounded dorsal lobes are deeply concave, and not reflected. In the young shell the septum is characterised by a conical depression placed on the dorsal margin close to the preceding whorl; as the shell enlarges this gradually decreases in size and depth, and ultimately disappears. It was of course moulded on a corresponding protuberance on the animal, probably an enlargement of the epithelial cincture. In some species the cavity is very deep. It was on this character that De Montfort, mistaking the depression for the mouth of a second siphuncle, founded his genus Bisiphites. The siphuncle is small and excentric. The lines of growth, like those of the preceding species, are decussated, and reflected backwards in broad undulations.

The Nautilus regalis attained a large size. The specimen figured, for the use of which I am indebted to Mr. Dixon, measures 9·5 in. in diameter, by 5 in. across. The species occurs at Islington, Regent's Park, Chalk Farm, Hyde Park, and at Bognor. It appears to have been one of the most common of the English Eocene Nautili. The septum is represented at Tab. VIII, fig. 5.

No. 9. Nautilus urbanus. *Sowerby.* Tab. III, fig. 2 *a—b.*

Nautilus urbanus. *J. D. C. Sowerby.* 1843. Min. Con. vol. vii, p. 36, pl. 628.
— — *Morris.* 1843. Cat. Brit. Foss. p. 183.
— — *Pictet.* 1845. Traité élément. de Paléont. vol. ii, p. 338.

N. Testâ discoideâ, in aspectu ventrali rotundatâ, et obscurè undulatâ; umbilicatâ; aperturâ subquadratâ, elongatâ; septis oblongis, concavis, in utroque latere leniter undulatis et siphone excentrico perforatis; lobis dorsalibus perbrevibus, obliquè truncatis, haud reflexis.

A flat discoidal shell, rounded on the ventral aspect, and presenting obscure undulations similar to those which characterise *N. regalis.* The aperture has an elongated, subquadrate shape; the umbilicus is narrow; the septa concave, and slightly undulated; they present on each side, in a line with the preceding whorl, a slight depression, which appears to be the first indication of the lateral lobes so fully developed in the *N. Parkinsoni;* the siphuncle is excentric approaching the dorsal margin; the dorsal lobes are short, very slightly concave, obliquely truncated, and not recurved. The lines of growth are prominent, and decussated more strongly than those of the two preceding species, and their undulations are broad and shallow.

The Nautilus urbanus is distinguishable from *N. centralis* by its flatness, and the greater length of its aperture; and from *N. regalis* by its open umbilicus, the truncated extremities of the dorsal lobes of the septa, and its discoidal shape. It is a very rare shell. The figures 2*a*, 2*b*, Tab, III, are taken from the shells drawn in 'Mineral Conchology,' the only specimens with which I am acquainted. The larger one, belonging to Mr. Sowerby, was found in excavating St. Katharine's Docks, near the Tower of London; the smaller one forms part of Mr. Bowerbank's collection, and was obtained from Sheppy.

The size of the larger individual figured is 7·4 in. in diameter, by 3·4 in. Fig. 4, Tab. VIII, represents the septum.

No. 10. Nautilus imperialis. *Sowerby*. Tab. V.

Nautilus imperialis.		*J. Sow.* 1812. Min. Con. vol. i, p. 9, tab. 1, upper and right-hand figures.
—	—	*Defrance.* 1825. Dict. des Sci. Nat., tome xxxiv, p. 297.
—	—	*Wether.* 1836. Philos. Mag. and Journ. vol. ix, p. 465.
—	Bucklandi.	*Michelotti.* 1840. Indice ragionato, &c. p. 4.
—	imperialis.	*Morris.* 1843. Cat. Brit. Foss. p. 182.
—	—	*Pictet.* 1845. Traité élément. de Paléont. vol. ii, p. 338.
—	—	*Sowerby.* 1849. Dixon's Geol. Hist. &c. pp. 110, 120.

N. Testâ sphæroidale; umbilicatâ, umbilicis angustis, profundis; aperturâ subellipticâ, semilunari; septis undatis, siphone mediocri dorso-excentrali perforatis; lobis dorsalibus latis et perparum reflexis.

This species is easily distinguished from the *N. centralis* by the excentric position of the siphuncle, as well as by the broad and reflected extremities of the dorsal lobes, which form, as it were, an axis to the shell. Its orbicular form, the lunate shape of the septa, and the recurved dorsal lobes, distinguish it as clearly from *N. regalis* and *N. urbanus.*

The *Nautilus imperialis* is a somewhat globose shell, rather narrow on the ventral aspect, whence the aperture assumes a sub-elliptical form; the umbilicus is small and deep. It is well displayed in the large figure, Tab. V, taken from a specimen in Mr. Bowerbank's collection, but generally, it is found open only in young shells; in the larger specimens it is usually filled with pyrites or indurated clay. The septa are deeply concave, and present a gentle undulation on each side; the dorsal lobes are very broad, inflected towards the axis, and obliquely truncated on the inferior margins. The siphuncle is moderately large, and excentric, being placed on the dorsal side of the centre of the disc. It appears to vary in its position, gradually becoming more distant from the dorsal margin as the shell enlarges. The lines of growth are reflected backwards in a deep narrow wave, and in the specimens I have seen are not decussated as in the three preceding species.

In the shell described by Michelotti under the name *N. Bucklandi*, and with which he has associated the present species, the siphuncle is central; and that character is, in fact, the reason assigned by him for considering his shell to be identical with *N. centralis* as well as with *N. imperialis*. Whether the alleged identification of *N. Bucklandi* with *N. centralis* be correct or not, it is obvious that the Piedmontese shell cannot be referred to the present species. Defrance states that the *N. imperialis* did not appear to differ from *N. centralis*, and Michelotti has, in fact, relied implicitly on that author; he has even copied the mistake made in quoting *N. centralis* as *N. australis*.

The *N. imperialis* attained a very large size; a specimen from Sheppy in the Museum of the Geological Society measures 12 inches by 8·75 in. across. It appears to have been widely spread, being found at Highgate, Hornsey, Brentford, Sheppy, Cuffell near Basingstoke, Clewett's Green, Newnham, Bognor, and Bracklesham. The form of the septum is shown in Tab. VIII, fig. 1.

No. 11. Nautilus Sowerbyi. *Wetherell.* Tab. VI.

Nautilus Sowerbyi. *Weth.* 1836. Phil. Mag. and Journ. vol. ix, p. 466.
— — *Morris.* 1843. Cat. Brit. Foss. p. 183.
— — *Sow.* 1843. Min. Con. vol. vii, p. 35, pl. 627, fig. 1-3.
— — *Sowerby.* 1849. Dixon's Geol. Hist. &c. p. 121, tab. 14, fig. 28.

N. Testâ lævigatâ, lenticulari, ventrali aspectu angustè rotundatâ; umbilicatâ, aperturâ sub-triangulari; septis profundè concavis; siphone continuo, prope margines dorsales posito, perforatis; utroque latere latè undulosis et sublobatis; lobis dorsalibus elongatis, valdè reflexis, obliquè truncatis.

The *N. Sowerbyi* is an exceedingly well-marked species. It is a smooth, discoidal, convex or rather lenticular shell, somewhat resembling in shape the Dax form of

Aturia (*Nautilus*) *zic-zac*, but it is narrower towards the margin, which circumstance gives a triangular form to the aperture. The septa (Tab. VIII, fig. 3) are very concave, and present on each side a broad undulation, with a deep sinus-like depression caused by a lateral lobe, more developed in this species than in *N. urbanus*, although not attaining the size and importance of that which distinguishes *N. Parkinsoni*.

The dorsal lobes are much recurved and obliquely truncated; the siphuncle is moderately large, placed very near to the dorsal margin, and continuous. The striæ of growth towards the middle are suddenly bent backwards in deep undulations.

This species, which attained a size of 10 inches in diameter by 4·2 in. across, was first obtained by Mr. Wetherell from the tunnel made at Chalk Farm for the Birmingham Railroad. It has also been found in the cuttings now in progress between Whetstone and Barnet for the Direct Northern Railroad, and it occurs at Sheppy and at Bognor, where it is very common.

No. 12. Nautilus Parkinsoni. *F. E. Edwards.* Tab. VII.

Nautilite. *Parkinson.* 1811. Organic Remains, p. 105, pl. 7, fig. 15.

N. testâ discoideâ, aperturâ elongato-ellipticâ, parietibus convexis; umbilicis (?); septis extùs concavis, in utroque latere angulariter lobatis, siphone, prope margines dorsales posito perforatis; lobis lateralibus brevibus, subtriangularibus, mucronatis; lobis dorsalibus latis, perparum concavis, ad extremitates attenuatis, reflexis.

Parkinson, in his work above cited, described the remains of a Nautilus, purchased by him at the sale of Dr. Menish's collection. These remains, which consist of the casts of three chambers, afterwards came into the possession of Mr. Sowerby, who has placed them at my service. Parkinson was ignorant of the locality whence they came; but from their mineralogical character, the matrix being, in fact, the substance known as cement-stone, it was supposed that they were found at Harwich. Lately the Rev. Thomas Image, of Whipstead, near Bury St. Edmunds, has forwarded to me for examination similar remains, unquestionably obtained at Harwich, and consisting of the casts of two chambers, rather smaller than those in Parkinson's specimen, and in a matrix precisely similar. The question, therefore, as to the locality of Parkinson's specimen is set at rest.

These remains are particularly interesting, from the circumstance that in them the angularly-lobed septum which characterises *Aturia* (*Nautilus*) *zic-zac*, and in that shell is accompanied by a strictly dorsal siphuncle, is associated with one which, although very excentric, is still so truly discal, as to prevent the shell being removed from the present genus. The form of the septum is a good specific character, but it cannot be relied upon as a generic distinction. The *Nautilus Parkinsoni*, therefore, although in general appearance it closely resembles *Aturia*, must, in fact, from the position of the siphuncle be considered as an aberrant *Nautilus*, connecting that genus with *Aturia*, and leading through the *Clymenidæ* into *Goniatites* and *Ammonites*.

The *N. Parkinsoni* is a discoidal shell, with regular convex sides, and an elongated elliptical aperture. The specimens do not exhibit the condition of the umbilicus. The septa are outwardly moderately concave, with angular lobes on each side; the dorsal lobes are very broad, somewhat concave, rounded at the extremities, and reflected, although not much, towards the axis; the lateral lobes are short, wide at the upper extremities, and they taper rather suddenly; their inferior margins are nearly straight, but the superior margins present a deep sinus. The siphuncle is moderately large, and is placed on the dorsal part of the septal disc, half way between the centre and the margin. So far as the general character can be ascertained, the siphuncle does not appear to differ from that of *Nautilus*, and certainly does not present any analogy with the wide trumpet-mouthed funnel which distinguishes *Aturia*.

This species appears to have attained a greater size than any other of the tertiary Nautili; the largest chamber in Parkinson's specimen measures seven inches in breadth, and nine inches in length; and this chamber was not the last, and consequently not the largest.

Family—Clymenidæ.

Aganidæ. *Pictet, Deshayes, D'Orbigny.*

Adopting the opinion of Von Buch, that the position of the siphuncle is the principal, if not the only, character by which the Tetrabranchiate Cephalopods can be divided into families, it becomes impossible to include those genera in which the siphuncle is placed on the *dorsal* margin, either among the Nautilidæ, in which it is *central* or *excentric*, or among the Ammonitidæ, in which it is placed on the *ventral* margin. The only genera at present known to possess a strictly dorsal siphuncle, are *Clymenia*, Munst. (*Endosiphonites*, Ansted), and *Aturia*, a genus proposed by Bronn for the *Nautilus Aturi*, Basterot (*N. zic-zac*, Sow.) In fact, these genera have already been considered by MM. d'Orbigny, Deshayes, and others, to form a subdivision of the Nautilidæ, to which those authors have applied the name Aganidæ, founded on a genus proposed by De Montfort for a shell from the mountain limestone. This shell, however, possessed a ventral siphuncle, and belonged to the genus Goniatites.* The name *Aganidæ*, therefore, cannot with propriety be retained as a family name for genera characterised by a *dorsal* siphuncle; and I have adopted, in lieu of it, the name *Clymenidæ*, founded on Munster's genus.

* The shell figured and described by De Montfort as *Aganides* is, I believe, the *Goniatites sphæricus* of Sowerby.

The septa in the *Clymenidæ* are distinguished by lateral rounded or angular lobes; but the angular form is not peculiar to the family; since, as we have already seen, it is found in *Nautilus Parkinsoni*, a species which, possessing an excentric siphuncle, must be considered as merely an aberrant form of Nautilus; and the separation of the *Clymenidæ* will depend entirely on the siphuncle being placed on the dorsal margin.

The two genera which belong to this family are distinguished chiefly by the mode of involution of the shell; the whorls in *Clymenia* being exposed, while in *Aturia* the last whorl conceals the rest; they therefore bear to each other the same relation which *Planulites* bears to the true *Nautilus*.

Genus 5th. Aturia.* *Bronn*, 1837.

Gen. desc. *A. testâ discoideâ vel subventricosâ, spirali, multiloculari, parietibus simplicibus; anfractibus contiguis, ultimo alios obtegente; umbilicis clausis; septis transversis, numerosis, extûs concavis, utroque latere angulariter lobatis et parte dorsali, magnâ siphone infundibuliformi, marginibus positâ, retro prolongatis; marginibus simplicibus.*

Shell discoidal or subventricose, spiral, multilocular, sides simple; whorls contiguous, the last concealing the others; the umbilicus closed; septa transverse, numerous, concave outwardly, with an angular lobe on each side, and having the dorsal part prolonged backwards, forming a large, marginal, funnel-shaped siphon; margins of the septa entire.

The angularly-lobed septum which distinguishes *Nautilus Parkinsoni* also forms a prominent character in the well-known Highgate fossil, *Naut. zic-zac*, figured and described by Mr. Sowerby in the first volume of the 'Mineral Conchology.' Bronn, in his description of the Dax shell *Nautilus Aturi* (Bast.), which he considered to be distinct from *N. zic zac*, suggested the propriety of forming a sub-genus, to be called *Aturia*, for the reception of those tertiary Nautili in which, according to the subgeneric description given by him, "the siphon is sub-ventral (i. e. sub-dorsal), and the septa have a deep, narrow, lancet-shaped flap on each side." The siphuncle, however, in the Dax shell, on which the genus is founded, is, in fact, strictly *marginal;* it is, as Bronn himself describes it, a prolongation backwards of the dorsal part of the septum, in the shape of a wide-mouthed funnel, extending quite across the preceding chamber, and deeply into the mouth of the preceding funnel. As this funnel-shaped siphon decreases in diameter, the dorsal paries gradually recedes from the margin, and the intervening space is filled up with a calcareous deposit. The siphuncle, therefore, will in some parts of its extent appear to be sub-marginal only: whereas the mouth of the

* Etym. Aturrus *vel* Aturus—the River Adour.

siphuncle, by which only the position can be determined, is perfectly marginal. The *Nautilus Aturi*, which I consider to be identical with *Nautilus zic-zac*, is the type of Bronn's genus, and I therefore retain the name proposed by that author, although I do not assent to the accuracy of his generic description.

The genus *Clymenia*, proposed by Count Munster for certain Nautiliform remains occurring in the transition limestones of Fichtelgebirge, presents nearly the same characters as those assigned by me to *Aturia;* except that in *Clymenia* the whorls are exposed, and the siphuncle is described as narrow; whereas in *Aturia* the last whorl conceals the others, and the siphuncle, at least in *A. zic-zac*, the typical species, is of great size.

The genus appears to have been confined to the tertiary epoch, and it is widely diffused. It occurs in the Eocene formations of England, France, Belgium, and Germany; in the Miocene deposits in the basins of the Gironde, in Italy, and in Malta. It is also found in the Eocene formation in Clarke county, Alabama, (U. S.), and Conrad* mentions a cast from the contemporaneous formation near Long Branch, New Jersey, resembling Nautilus (Aturia) zic-zac, but more compressed, and which he has referred to De Montfort's genus *Pelagus*, and has named *P. Vanuxemi.* De Montfort's *Pelagus*, however, is described as having "cloisons lobées, *persillées*, *dentelées*, &c." The position of the siphuncle is not mentioned in De Montfort's text; but in the figure he has given it is placed on the ventral margin. The shell, therefore, on which the genus Pelagus is founded is an Ammonite, and the species constituting the present group cannot be associated with it.

No. 13. Aturia zic-zac. *Bronn.* Tab. IX, fig. 1*a*—*h.*

Var. *a.* Nautilus zic-zac. *Sow.* 1812. Min. Con. vol. i, p. 9, pl. 1, fig. 3.
Ammonites Wapperi. *Van Mons.* 1833. L'Institut. 1833, p. 272.
— — — 1834. Bull. de l'Acad. de Brux. tome i, No. 17, pp. 113, 118.
Nautilus Deshayesii. *De Koninck.* 1834. Notice sur un Moule pyriteux du Naut. de Desh.; Bull. Soc. Géol. de France, t. iv, p. 437.
— — *Nyst.* 1835. Rech. sur les Coq. foss. de la Prov. d'Anvers, p. 35, No. 52.
— — *De Koninck.* 1837. Desc. des Coq. foss. de l'Argile de Basele, p. 1.
— Aturi. *Bronn.* 1837. Leth. Geog. vol. ii, p. 1123, pl. 42, fig. 17*a*—*c.*
— zic-zac. *Desh.* 1837. Desc. des Coq. foss. des Env. de Paris, vol. ii, p. 765, pl. 100, figs. 2, 3.
Clymenia zic-zac. *Michelotti.* 1840. Annal. Scient. reg. Lomb. Venet. p. 6.

* Conrad's "Observations on the Eocene formation, and description of one hundred and five new fossils of that period, from the vicinity of Vicksburg, Mississippi," published in the Journal of the Academy of Natural Science of Philadelphia.

Nautilus zic-zac. *Nyst.* 1843. Bull. Soc. Géol. de France, vol. xiv, p. 452.
— — — 1843. Desc. des Coq. foss. &c. des Terr. tert. de la Belgique, p. 644, pl. 46, fig. 4.
— — *Morris.* 1843. Cat. Brit. Foss. p. 183.
Aganides Deshayesii. *Sismonda.* 1847. Method. Anim. invert. Pedemontii Foss. p. 57.
— zig-zag. *Pictet.* 1845. Traité élément. de Paléont. Vol. ii, p. 341.
Nautilus (Clymenia ?) zic-zac. *Sow.* 1849. Dixon's Geol. Hist. &c. p. 109, pl. 8, fig. 19.
Var. β. Nautile de Dax. *De Montf.* 1802. Buffon de Sonnini Moll. vol. iv, pp. 240, 252, pl. 46, fig. 1.
Nautilus Pompilius. *Lam.* Ann. du Mus. vol. v, p. 181.
— — — 1822. An. sans Vert. vol. xvi, p. 634.
— Deshayesii. *Defr.* 1825. Dict. de l'Hist. Nat. vol. xxxiv, p. 200.
— Aturi. *Bast.* 1825. Desc. des Coq. foss. des Env. de Bordeaux, p. 17.
Orbulites zic-zac. *De Blainv.* 1825. Man. de Malac. p. 387.
Nautilus (Aganides) Aturi. *D'Orb.* 1825. Tab. méthod. de la Classe des Céph. p. 71.
— Sypho. *Buckl.* 1836. Bridgw. Treat. vol. i, p. 357, pl. 46, figs. 1-4.
— — *Grateloup.* 1838. Cat. des An. vert. et invert foss. du Basin de la Gironde, p. 28.
Aganides Aturi. *Pictet.* 1845. Traité élément. de Paléont. Vol. ii, p. 341.

A. Testâ ventricosâ, lævigatâ; umbilicis clausis; septis concavis; lobis lateralibus angustis, acutis; dorsalibus valdè recurvis; siphone magno, continuo, buccinæformi.

Var. β. *Testâ compressâ, sub-discoideâ; septis profundè concavis, lobis dorsalibus angustioribus.*

Shell ventricose, smooth; umbilicus closed; septa concave; lateral lobes narrow, pointed; dorsal lobes much curved; siphuncle large, continuous, trumpet-shaped.

There are scarcely any tertiary remains which have excited so much attention as the present; not merely because the species is widely diffused, but because it presents an intermediate form between the Nautili and the Ammonites; and few fossils have been referred to more genera, or have been distinguished by a greater number of specific names.

The *Aturia zic-zac* was first described by Mr. Sowerby, sen., as Nautilus zic-zae, from a speeimen which was found on forming the tunnel of the Highgate Archway. Several years afterwards M. Defrance described a specimen from the Paris basin, and pointed out the differences which, in his opinion, rendered it difficult to refer the species to the genus *Nautilus.* M. Defranee considered the fossil described by him as distinct from the *N. zic-zac*, and gave to it the specific name *Deshayesii.* Subsequently Basterot described the well-known Dax fossil, which he named *Naut. Aturi*, and with which he considered the *Naut. zic-zac* to be identical. M. d'Orbigny and Sig. Sismonda, not regarding the dorsal position of the siphunele, but relying on the angular lobes which characterise the septa, have referred the shell in question to De Montfort's *Aganides*, a genus which, as has been before stated, was founded on a *Goniatite* from the mountain limestone. Michellotti, on the other hand, has considered the present remains as forming part of Munster's *Clymenia*, a genus distinguished by its having the whorls exposed.

The Aturia zic-zac is a smooth, involute shell, more or less ventricose or depressed; the septa are outwardly deeply concave; and, owing to the regular curve in which the dorsal lobes are reflected towards the axis of the shell, they present, when viewed sideways, some resemblance to the letter S; the lateral lobes are more or less narrow, and taper rather suddenly towards the inferior extremity, which extends nearly to the preceding septum; but they are without the sinus which characterises the lateral lobes of *Naut. Parkinsoni*. The English shells are generally either casts in, or filled with pyrites, and it is difficult to ascertain the character of the siphuncle from them; but in the Dax shells, in which the calcareous siphon is frequently well displayed, it presents a structure widely different from that of the Nautilus. The dorso-marginal part of the septum, as I have before observed, is prolonged backwards in the form of a wide trumpet-mouthed funnel, which extends not only into the mouth of the funnel formed by the preceding septum, but along the preceding siphuncle almost to the floor of the third preceding chamber (see Tab. IX, fig. 2*a*). The calcareous siphuncle, therefore, is, in fact, a continuous tube of considerable thickness, composed of portions of two distinct tubes; and within this is contained a soft, friable, calcareous sheath, which commences near the extremity of the funnel, where it touches the preceding funnel, and extends to the end of the preceding funnel, to the interior surface of which it forms a sheath. Although, owing to the thickness of the walls and the presence of the calcareous sheath, the actual tube within which the membranous siphuncle was contained is not so capacious as might be expected from its external appearance, it is yet considerably larger than that of any of the tertiary Nautili; and indeed it is of such size and importance as fully to justify the name *Sypho*, which Grateloup has given to the Dax shell. The siphuncle in the English specimens, so far as its character can be ascertained, appears to correspond exactly with that of the Dax shells.

Great diversity of opinion has existed, and, in fact, still exists, as to the identity of the Dax shell with the *Naut. zic-zac* of Sowerby. The differences which have been relied on for the separation of the two appear to me to result from the more compressed form of the Dax shells; the specimen figured by Mr. Sowerby, although described as "flattish," being ventricose, and the outline of one of the septa drawn below the shell conveying the idea of greater fulness than in fact characterises the fossil. M. Deshayes, who compared the Dax shells with specimens as well from the Paris basin as from Belgian and English localities, expressed an opinion that the differences were sufficient to form, if not two species, at least two well-marked varieties. I have not myself had an opportunity of examining any French or Belgian specimens; but, through the kindness of Mr. Sowerby, Mr. Bowerbank, and Mr. Wetherell, who have afforded me the use of their specimens, I have before me a series of shells from Sheppy and the neighbourhood of London, including the identical specimen figured by Mr. Sowerby. Confining myself to external characters only, two distinct forms occur in this series, the differences in which, although they may require a separation into varieties, are not sufficient, in my opinion, for specific distinctions.

In the first variety, which is the true Naut. zic-zac, figured in 'Mineral Conchology,' and which I have therefore taken for the typical form, the shell is ventricose, the greatest width being little less than half the diameter; it is moderately round on the ventral aspect, and the aperture is a somewhat elongated ellipsis. In the other variety (β) the shell is more compressed, almost discoidal; and consequently it is narrower on the ventral aspect; the dorsal lobes are not so broad, and the aperture is of a more elongated oval form.

The French, Belgian, and German shells correspond apparently with the first, the typical form, and the Dax shells agree closely with the second variety. Michellotti has used for the Piedmontese specimens the specific description given by M. Deshayes; but he adds, that "they present some trifling differences from the Paris specimens, as do the latter from the London and Bordeaux shells." As, however, the Piedmontese shells are described as "ventricose," they must for the present be referred to the typical form, although we should naturally expect to find the Dax type continued in the Miocene formations of the Colle de Torino.

The Aturia zic-zac also occurs in the Miocene deposits in Malta, and the specimens which I have seen from that locality present the depressed form of the Dax shells, with which they agree in other respects.

Mr. Sowerby possesses a series of casts from the Eocene formation in Clarke County, Alabama, of a species which approaches very near to the typical *Aturia zic-zac;* the chief distinction appears to be in the form of the lateral lobes, which in the American shell extend quite to the margin of the preceding septa, and have their extremities inflected towards the axis, and present the deep sinus which characterises the lateral lobes of *Naut. Parkinsoni.* The siphuncle is very large, and corresponds with that of *A. zic-zac.* Conrad describes his *Pelagus Vanuxemi* as more compressed than the latter shell, and he adds that "the angles of the septa appear to be in contact near the periphery." This appearance, which is attributable to the length of the lateral lobes, and is represented in the figure given by Conrad by a continuous line running parallel with the periphery of the shell, is also found in the Alabama specimens, of which Conrad's shell is possibly only a compressed variety.

The typical form, which is represented at Tab. IX, fig. 1*a*, 1*b*, drawn from the original specimen figured in 'Mineral Conchology,' for the use of which I am indebted to Mr. Sowerby, is found at Highgate, Sheppy, and Bracklesham Bay. The variety β, which corresponds with the Dax shells, was obtained from the railroad cutting at Chalk Farm, and from the well sunk for the use of the Orphan School, at Haverstock Hill, near Hampstead. The specimen figured (Tab. IX, fig. 1*g*, 1*h*,) is from the former locality; it is the one drawn by Mr. Charlesworth in the 'Magazine of Natural History,' vol. i, (new series,) p. 533, and forms part of Mr. Wetherell's valuable collection of fossils from Highgate and the neighbourhood.

The English shells are apparently young; they are much smaller than the Dax specimens, the largest I have seen cannot have exceeded 1·6 in. in diameter.

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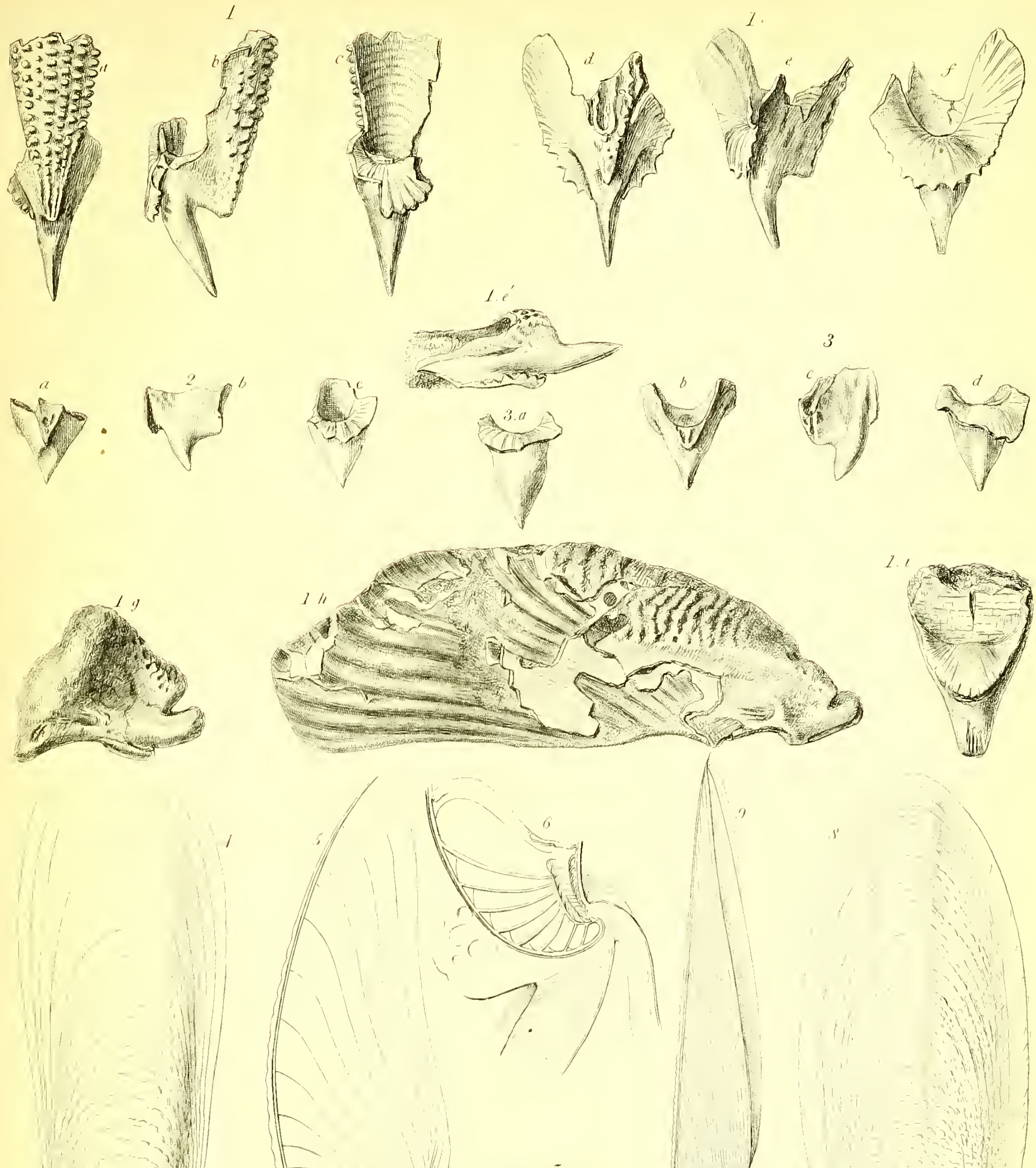
TAB. I.

Fig.

1. Belosepia Sepioidea, *p.* 29.
   - 1*a*—*c*. Var. B. longirostris.
     - *a*. Dorsal aspect.
     - *b*. Side view.
     - *c*. Ventral aspect.
   - 1*d*—*f*. Var. B. longispina.
     - *d*. Dorsal aspect.
     - *e*, *e′*. Side views.
     - *f*. Ventral aspect.
   - 1*g*—*i*. Var. B. Blainvillii.
     - *g*. Side view.
     - *h*. Do. of a cast of the Belosepion (B. Sepioidea).
     - *i*. Ventral aspect.
2. Belosepia brevispina, *p.* 32.
   - *a*. Dorsal aspect.
   - *b*. Side view.
   - *c*. Ventral aspect.
3. Belosepia Cuvieri, *p.* 31.
   - *a*, *d*. Ventral aspect.
   - *b*. Dorsal aspect.
   - *c*. Side view.
4. Dorsal aspect of the Belosepion (B. Sepioidea).
5. Longitudinal section of ditto.
6. Enlarged view of the terminal cavity and rostrum in the same section.
7. Enlarged view of an obliquely transverse section of the terminal cavity.
8. Dorsal aspect of the sepion (Sepia officinalis).
9. Longitudinal section of ditto.
10. Enlarged view of section of the rostrum of ditto.

Tab. 1.



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TAB. II.

1*a*—*g*. Beloptera Belemnitoidea, *p*. 36.

a. Ventral aspect.
b. Dorsal do.
c. Side view.
d. Longitudinal section.
e. Magnified view of do.
f. Ventral aspect of variety.
g. Dorsal aspect of do.

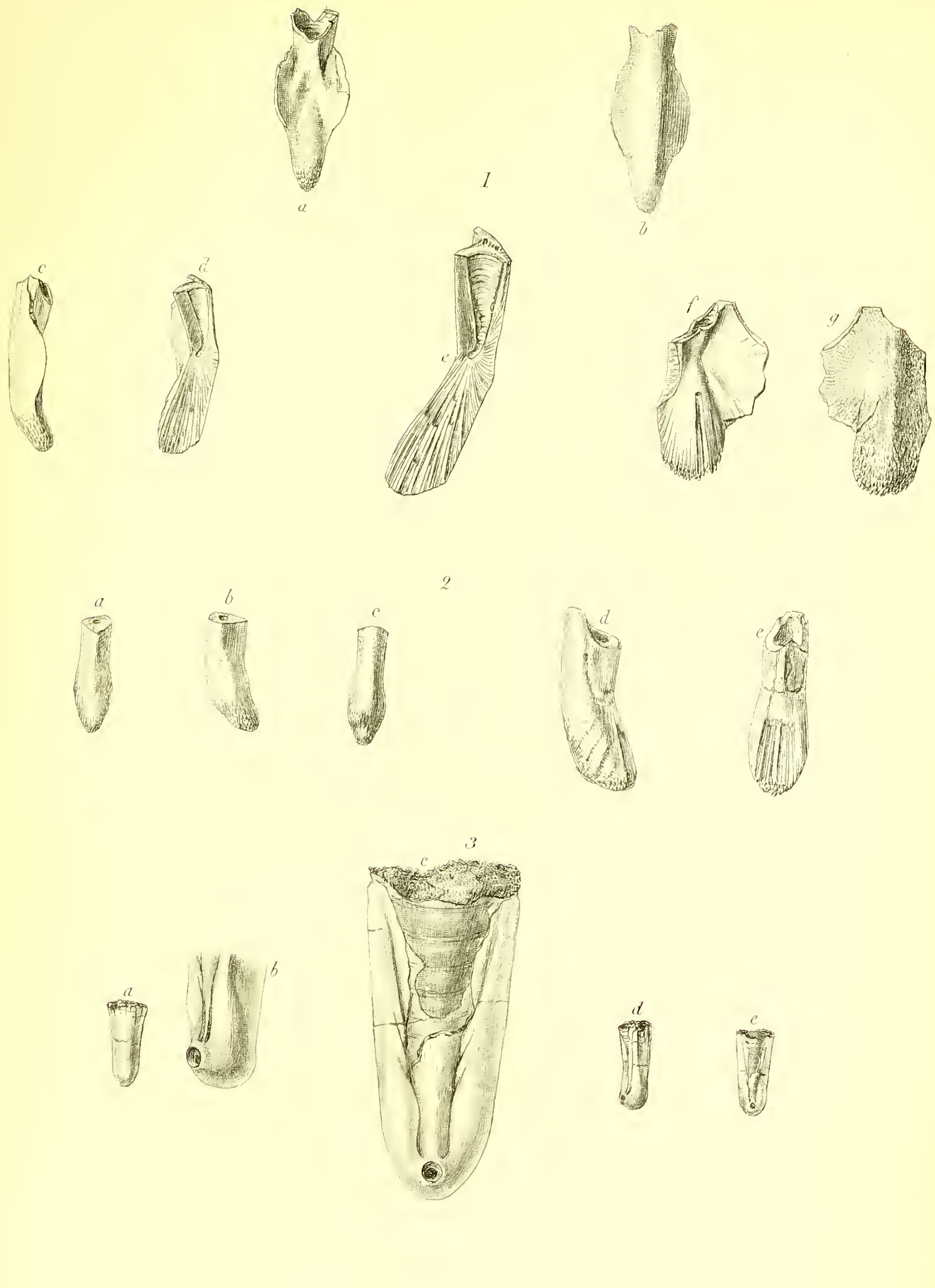
2*a*—*e*. Beloptera Levesquei, *p*. 37.

a. Ventral aspect } of a young specimen.
b. Side view } of a young specimen.
c. Dorsal aspect } of a young specimen.
d. Side view of an adult specimen.
e. Ventral aspect of ditto.

3*a*—*e*. Belemnosis plicata, *p*. 40.

a. Dorsal aspect, nat. size.
b. Side view (enlarged) of the umbonal pore.
c. Ventral aspect enlarged.
d. Side view, nat. size.
e. Ventral aspect, ditto.

Tab. II.



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TAB. III.

Fig.

1*a*—*c*. Nautilus centralis, *p.* 45.

a. Back view.

b. Side view.

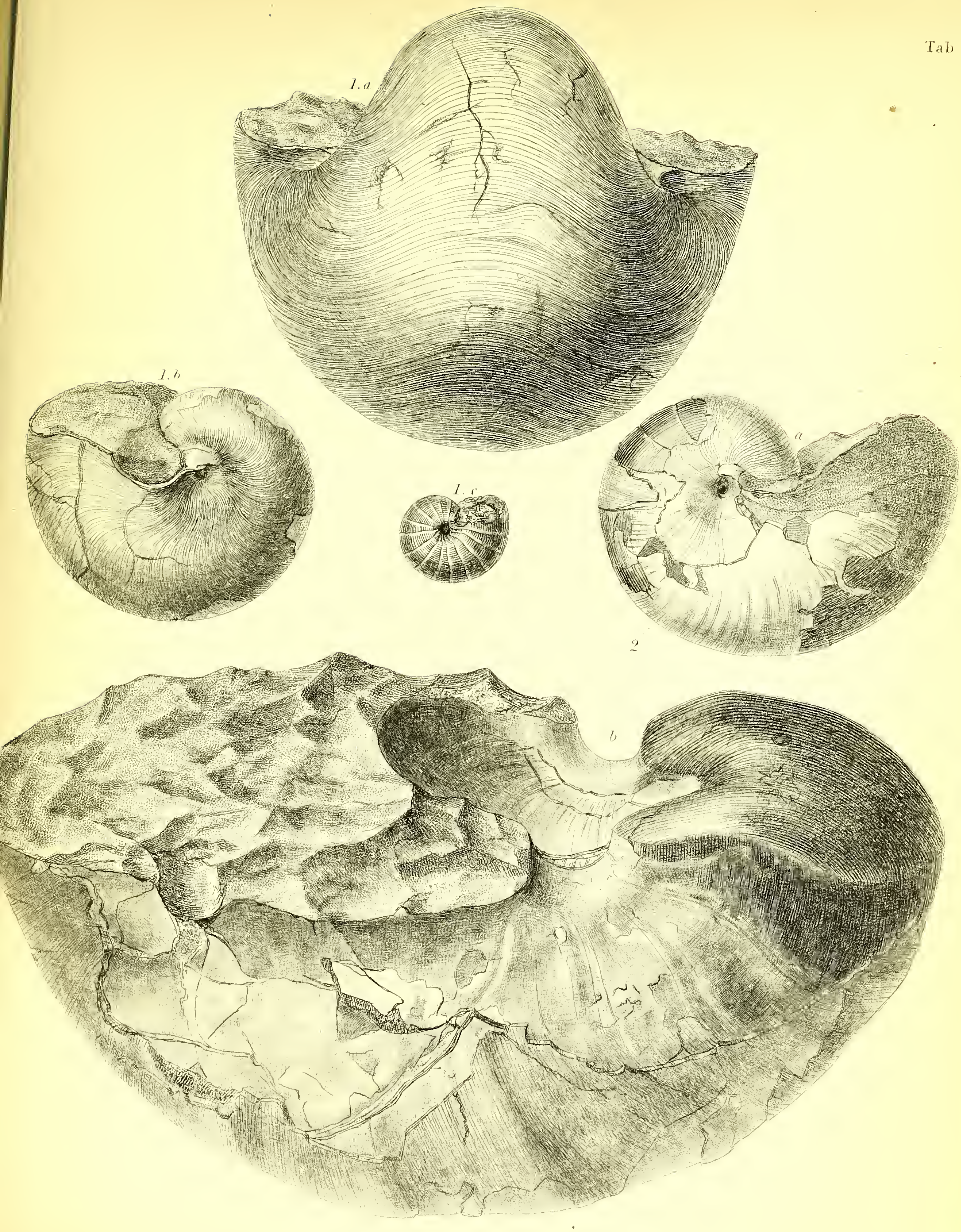
c. Do., young shell.

2*a*—*b*. Nautilus urbanus, *p.* 46.

a. Side view, young shell.

b. Do., adult do.

Tab III



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Nautilus regalis. p. 16.

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Nautilus imperialis p. 47.

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Nautilus Sowerbyi p. 18.

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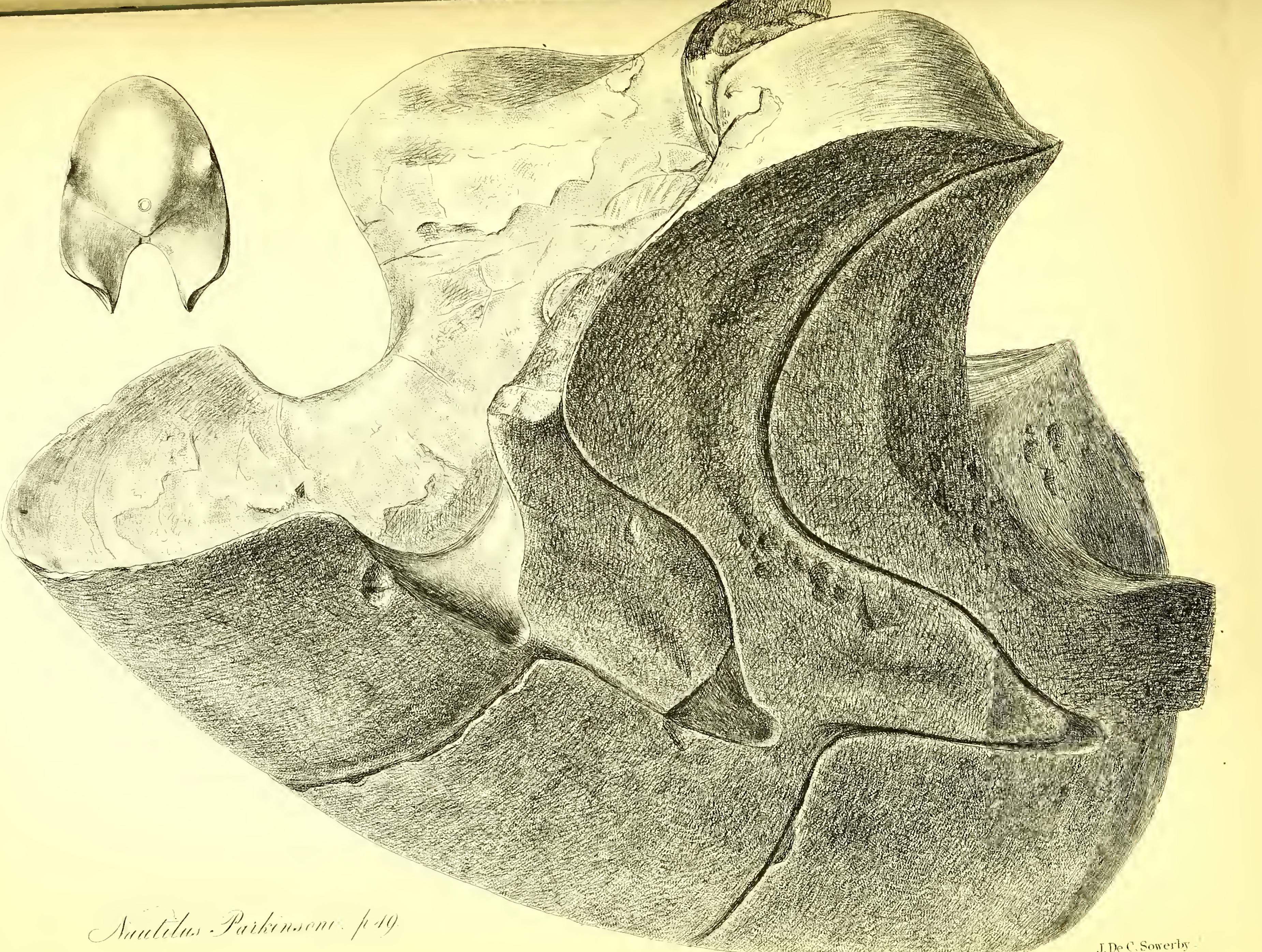

Nautilus Parkinsoni. p.19

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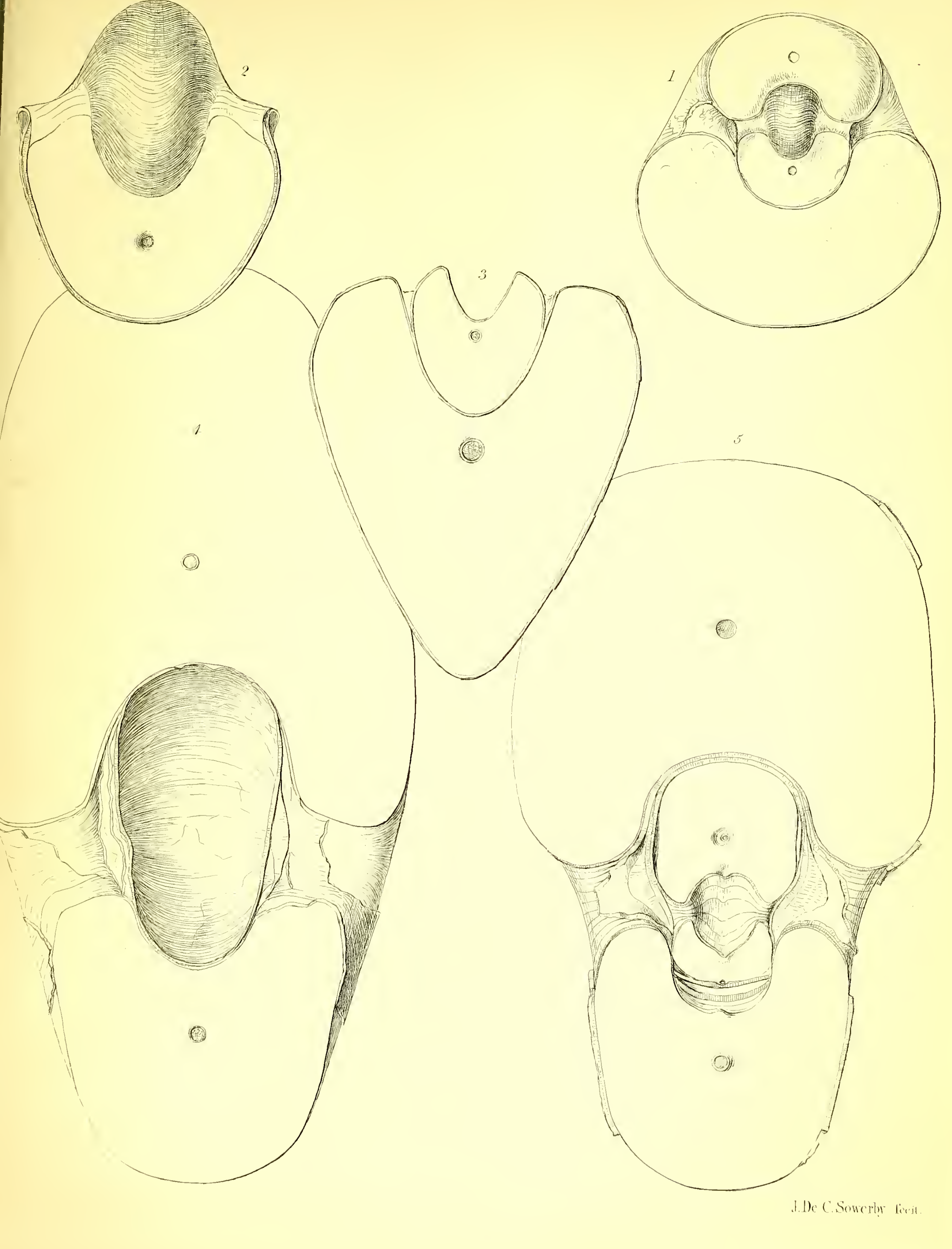
TAB. VIII.

Fig.			
1.	Transverse section showing the form of the septum in		Nautilus imperialis, *p*. 47.
2.	Do.	do.	N. centralis, *p*. 45.
3.	Do.	do.	N. Sowerbyi, *p*. 48.
4.	Do.	do.	N. urbanus, *p*. 46.
5.	Do.	do.	N. regalis, *p*. 46.

Tab. VIII.



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TAB. IX.

Fig.

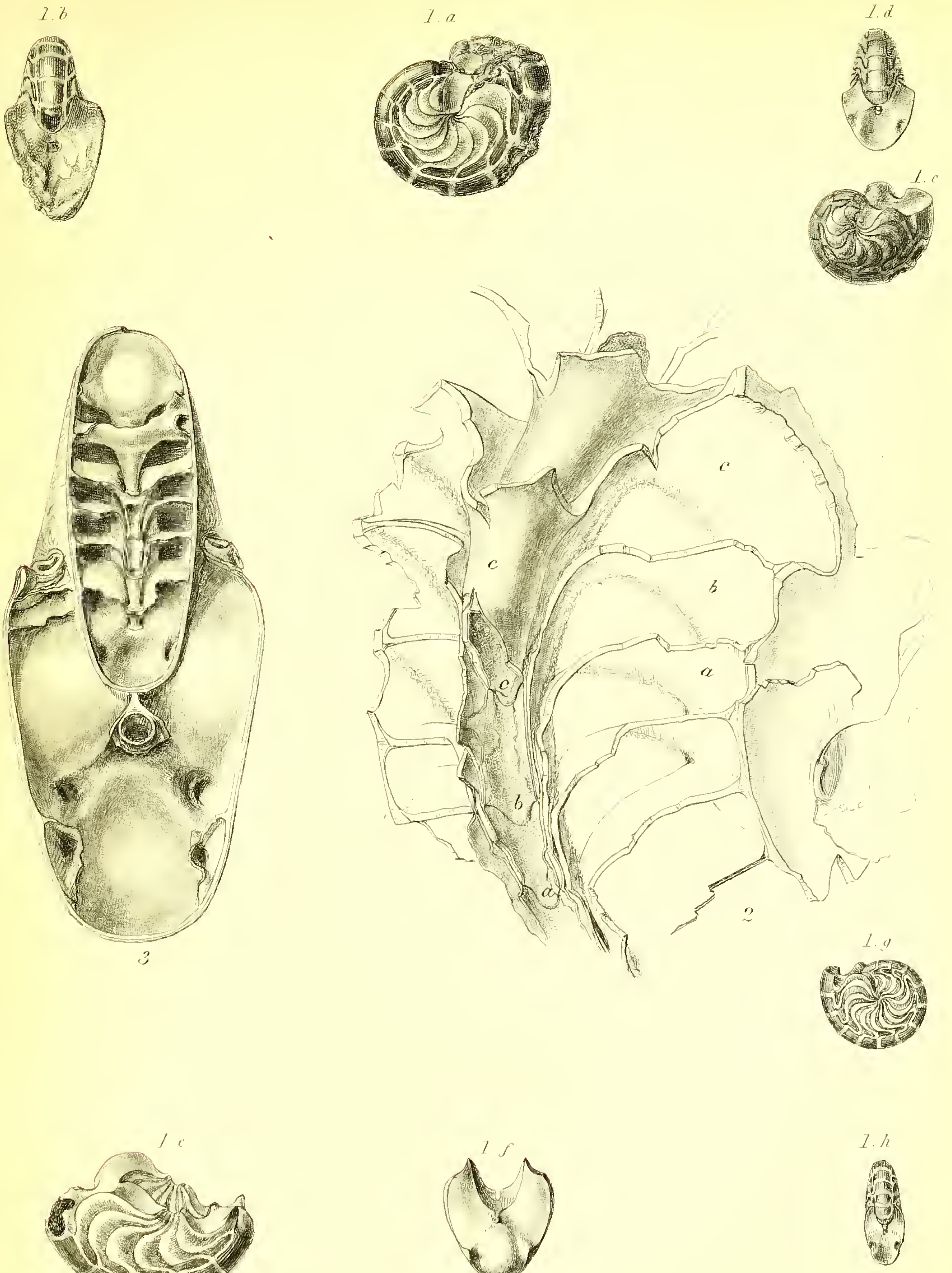
1*a*—*h*. Aturia zic-zac (English specimens), *p.* 52.

a.	Side view of the typical form, from Highgate.		
b.	Front view	do.	do.
c.	Side view	do.	from Sheppy.
d.	Front view	do.	do.
e.	Side view	do.	from Bracklesham Bay.
f.	Front view	do.	do.
g.	Side view of the compressed variety (β), from Chalk Farm.		
h.	Front view	do.	do.

2 and 3. Aturia zic-zac (Dax specimens).

2. Oblique view, showing the construction of the siphuncle.
3. Front view, showing the form of the septum.

Tab. IX.



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